



THE UNIVERSITY *of* EDINBURGH

This thesis has been submitted in fulfilment of the requirements for a postgraduate degree (e.g. PhD, MPhil, DClinPsychol) at the University of Edinburgh. Please note the following terms and conditions of use:

This work is protected by copyright and other intellectual property rights, which are retained by the thesis author, unless otherwise stated.

A copy can be downloaded for personal non-commercial research or study, without prior permission or charge.

This thesis cannot be reproduced or quoted extensively from without first obtaining permission in writing from the author.

The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the author.

When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given.

DOCTORAL THESIS

Wage Inequality in the Global Economy

Author:

Sarah Schröder

Supervisor:

Dr. Robert Zymek



The University of Edinburgh
School of Economics

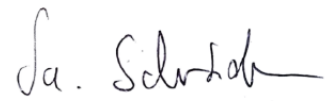
*This thesis is submitted in fulfillment of the requirements
for the degree of Doctor of Philosophy*

July 18, 2019

Declaration of Own Work

I declare that this thesis was written and composed by myself and is the result of my own work unless clearly stated and referenced. This thesis has not been submitted for any other degrees or professional qualifications.

Sarah Schröder


Oct. 18th 2018

To Jane, Hardmuth, Kathrin, Stefan and Caroline

Acknowledgments

This thesis is the final output of my PhD studies at the University of Edinburgh and as a visiting student at Universitat Pompeu Fabra. I take this opportunity to extend my sincere gratitude and appreciation to all those who made this thesis possible. First and foremost, I owe my deepest gratitude to Robert Zymek, who has been my supervisor, mentor and a guiding beacon throughout these four years. His enthusiasm, unconditional support, and especially his brilliant economic intuition and rigorous attention to detail, have set an example I hope to match some day. I am also indebted to my second supervisor Sevi Rodriguez-Mora. I have greatly benefited from his genius comments and breadth of knowledge, especially when developing new ideas. Special thanks to Jaume Ventura for his support and our invaluable discussions during my stay at UPF. Furthermore, detailed discussions with Giacomo Ponzetto, Andrew Bernard, Asier Mariscal, Randall Ellis, Yoto Yotov, Kenneth Mirkin and Ahmed Anwar have been insightful and truly inspiring. I also wish to thank my fellow PhD students at the UoE and UPF for their unconditional support and helpful comments. In particular, I would like to thank Aodi Tang, Jonathan Spiteri, Tomasz Sulka, Aspasia Bisopoulou, Cristina Lafuente, Ludovic Feumo, Juraj Briskar, Ines Xavier and Juan Imbet. I am grateful to the PhD directors and administrative staff for providing invaluable support. Most of all, I would like to thank my parents, my sister Kathy, my brother Stefan and my dear aunty Carol for their prayers, love and encouragement throughout my life. Lastly, I give thanks to God, who has been the source of every blessing, strength, peace, hope, faith and joy.

Abstract of Thesis

This thesis is devoted to understanding the driving forces of growing wage inequality across and within countries. My research aims to empirically assess and to find theoretical justifications for two features of wage inequality: First, wage inequality among workers who are similar in education, age, and other characteristics, i.e. 'residual wage inequality' and second, the growing wage gap between workers of different skill groups, i.e. the skill-premium.

Chapter 1. Wage Inequality and the Role of Multinational Firms: Evidence from German Linked Employer-Employee Data This chapter contributes to our understanding of how firms' diverse international activities affect wage inequality between observationally identical workers. Using German linked employer-employee data, this study investigates the wage premium of exporters and multinational enterprises, controlling for observable and unobservable firm and worker heterogeneity. In doing so, this study is among the first to (1) jointly estimate the exporter and the multinational wage premium and (2) to further distinguish between wage premia of multinational firms that are foreign owned (inward FDI) and domestically owned (outward FDI). I find evidence that the wage premium of multinational firms is larger than the exporter premium. Moreover, my findings suggest that the so called 'exporter wage premium', as found by previous studies, is in fact driven by multinationals that engage in exporting activity. Another important contribution of the paper is to document the skill and task structure of wage premia and

employment. My findings exhibit a clear hierarchy of firms' international activities with regard to wage premia for different skill groups and the average observed and unobserved workforce ability, where MNEs can be ranked highest. This observed pattern between the ranking of wages and the skills required, suggests worker-firm-type complementary.

Chapter 2. Heterogeneous Globalisation, Labour Market Rigidities and Wage Inequality This chapter proposes a theoretical model to study the implications for wage inequality of two distinct forms of globalisation, namely trade and foreign direct investment. The model exhibits a clear hierarchy of firms' international activities with regard to firm size, average workforce ability and wage premia, where firms engaging in foreign direct investment can be ranked highest. The mechanism is based on a model with ex-ante homogeneous workers, heterogeneous firms and search and matching frictions within a two-country two-sector trade model with monopolistic competition. By including foreign direct investment by multinational firms, this paper provides novel insights into the interaction between firm specific factors and firms' international activities in determining wage inequality and in particular, the multinational wage premium. Furthermore, the comparative statics exercise in this paper shows that the interdependence between labour market rigidities and firms' mode of foreign market entry, implies that changes in a country's labour market institution changes the distribution of exporters and multinational firms within and across countries.

Chapter 3. Accounting for Skill Premia across Countries and Time This chapter uses the structure of a two-sector two-factor model to attribute changes in the skill premium across countries to three potential sources: (i) changes in the relative abundance of skilled workers, (ii) technological change and (iii) market size effects due to external economies of scale. I employ the development and growth accounting methodology as analytic tool to assess the relative importance of each

one of these channels in explaining changes in the skill premium across countries and time. My findings add to the growing evidence that there is hardly any association between changes in the relative supply of skills and the observed evolution of the skill-premium. Furthermore, I show that the measure of the importance of market size effects governs the strength of the relationship between technological change and the skill-premium. Moreover, for strong enough economies of scale, an increase in the relative supply of skills increases the the skill premium. Importantly, this finding points out that the scale of the economy may be an important factor in shaping developments of the skill premium, independent of the specific features of technological change.

Lay Summary

Debates about the economic role of wages have intensified in recent years. Wages are the market price of labour and therefore, a key signal in the process of allocating labour resources to their most productive employment opportunities. Moreover, wage differentials for workers with varying educational levels create additional incentives for investment into human capital. Furthermore, in a global context, differences in the returns to skill across countries are said to be a driving force of immigration flows and brain drain in particular. In light of the economic significance of wage differentials between workers within and between different skill groups, this thesis is devoted to understanding the driving forces of growing wage inequality in the context of a globalising world.

My first chapter uses German linked employer-employee data to empirically assess the link between increasing globalisation and wage inequality. The literature, studying the effects of globalisation on wage inequality, has established that exporters pay more for seemingly identical workers - known as the exporter wage premium. At the same time, the recent surge in multinational activity, measured by foreign direct investment (FDI), has broken the link between foreign sales and exports. In fact, the recent growth of FDI has caught up and at times outpaced the growth of trade and income. This recent development raises the following questions I address in this chapter: first, is it exporting per se or multinationals with exporting activity that contribute to wage inequality between observationally identical workers? Second, how do firms' diverse internationalisation decisions affect the employment structure

within a firm and the skills demanded? I find evidence that multinational firms pay higher wages than both exporters and firms that are only active in the domestic market. Moreover, my findings suggest that the so called 'exporter wage premium', as found by previous studies, is in fact driven by multinationals that engage in exporting activity. Another important contribution of the paper is to document the skill and task structure of wage premia and employment. My findings exhibit a clear hierarchy of firms' international activities with regard to wages for different skill groups and the average observed (e.g. educational level and complexity of tasks performed) and unobserved (e.g. productivity of the worker, communication skills etc.) workforce ability, where multinational firms can be ranked highest. This observed pattern between the ranking of wages and the skills required, suggests that some skills and types of knowledge are more valuable to firms that are internationally active, such as language skills, team work or leadership ability.

The second chapter builds a theoretical model that is able to explain these empirical findings. In doing so I am able to study the implications for wage inequality of two distinct forms of globalisation, namely trade and foreign direct investment. In line with my empirical findings, the model exhibits a clear hierarchy of firms' international activities with regard to firm size, average workforce ability and wages, where firms engaging in foreign direct investment can be ranked highest. The mechanism is based on a model with ex-ante identical workers, heterogeneous firms and labour market frictions within a two-country two-sector trade model with monopolistic competition. By including foreign direct investment by multinational firms, this paper provides novel insights into the interaction between firm specific factors and firms' international activities in determining wage inequality and in particular, the multinational wage premium. Furthermore, the comparative statics exercise shows that the interdependence between labour market rigidities and firms' mode of foreign market entry, implies that changes in a country's labour market institution, changes the distribution of exporters and multinational firms within and across countries.

In the third chapter of my thesis I turn to a more traditional aspect of wage

in quality that has been a central topic in economic analysis and policy debate, namely the increase in wage inequality between workers of different skill groups. Applying the basic economic principle of supply and demand in order to understand changes in the relative wage of skilled workers (skill premium), predicts that an increase in the relative supply of skills ought to decrease the premium the labour market pays for skills. A closer look at recent developments of the skill premium in several countries, however, suggests that for some countries exactly the opposite is true. Using data for 36 countries from 1983-2008, I show that despite the large increase in the share of educated people in most countries, the skill premium has failed to decrease during the same period. This puzzling observation motivates the analysis of this chapter. I use the structure of a two-sector two-factor model to attribute changes in the skill premium across countries to three potential sources: (i) changes in the relative abundance of skilled workers, (ii) technological change and (iii) market size effects due to external economies of scale. I employ the development and growth accounting methodology as analytic tool to assess the relative importance of each one of these channels in explaining changes in the skill premium across countries and time. My findings add to the growing evidence that there is hardly any association between changes in the relative supply of skills and the observed evolution of the skill-premium. Furthermore, I show that the measure of the importance of market size effects governs the strength of the relationship between technological change and the skill premium. Moreover, for strong enough economies of scale, an increase in the relative supply of skills increases the skill premium. Importantly, this finding points out that the scale of the economy may be an important factor in shaping developments of the skill premium, independent of the specific features of technological change.

Contents

Declaration of Own Work	i
Acknowledgments	iii
Abstract of Thesis	v
Lay Summary	ix
1 Wage Inequality and the Role of Multinational Firms: Evidence from German Linked Employer- Employee Data	1
1.1 Introduction	1
1.2 Data	8
1.2.1 Data Description	8
1.2.2 Descriptive and Non-parametric Statistics	11
1.3 The Exporter and MNE Wage Premium	14
1.3.1 Empirical Methodology - Wage Premia	14
1.3.2 Estimation Results - Wage Premia	18
1.3.3 Robustness Checks	27
1.4 The Skill and Task Structure of Wage Premia and Employment . . .	28
1.4.1 Workforce Composition	28
1.4.2 Wage Premia across Skill Groups and Task Levels	33
1.5 Concluding Comments	37
Bibliography	39

2	Heterogeneous Globalisation, Labour Market Rigidities and Wage Inequality	45
2.1	Introduction	45
2.2	The Model	51
2.2.1	Model Setup	51
2.2.2	Model Solution	57
2.3	Model Implications	68
2.3.1	Exporter and MNE Wage Premia	68
2.3.2	Comparative Statics	71
2.4	Conclusion	75
	Bibliography	78
3	Accounting for Skill Premia across Countries and Time	85
3.1	Introduction	85
3.2	The Model	89
3.2.1	Setup	89
3.2.2	Equilibrium	91
3.2.3	Special Cases	95
3.3	Accounting for Skill-Premium Changes	97
3.3.1	Data Sources	98
3.3.2	Data Description and Parameters	100
3.3.3	Accounting Methodology	102
3.3.4	Accounting with $\mu = 1$	104
3.3.5	Accounting with $\mu > 1$	105
3.4	Discussion	107
3.4.1	Market size effects and the measure of <i>ignorance</i>	107
3.4.2	Interpretation and Implications	109
3.5	Conclusion	110
	Bibliography	110

Appendix A	116
Appendix B	121
Appendix C	125

List of Figures

1.1	Wage density by firm-type	2
1.2	Relative Frequency of Firm-type Switchers	17
2.1	Share of Workers in Exporting and FDI Firms in Germany (2006-2010)	46
2.2	Timing of Decisions	55
3.1	Relative changes in skill-supply and the skill-premium (1983-2007) . .	86
3.2	The measure of <i>ignorance</i> and the importance of market size effects (μ)	107

List of Tables

1.1	Number of firms and workers by firm-type (2006)	12
1.2	Firm - Worker Statistics	13
1.3	Unravelling the different Wage Premia (2006)	19
1.4	Controlling for Unobserved Heterogeneity	22
1.5	Analysing Firm-Type Switchers	25
1.6	Sorting Patterns - Unobserved Ability and Firm Types (2006)	30
1.7	Share of High Skilled Workers (2006)	32
1.8	Share of Workers performing Complex Tasks (2006)	34
1.9	Wage Premia by Education and Task Level	36
3.1	Summary Statistics for w_H/w_L	100
3.2	Summary Statistics for $H/(H + L)$	101
3.3	Data and Parametrisation Strategy	102
3.4	Summary Statistics for changes in RTFP ($\mu = 1$)	104
3.5	Summary Statistics for changes in RTFP for $\mu = 1.14$	106
3.6	<i>ignorance</i> and the importance of market size effects (μ)	108
A.1	Robustness 1 - Unravelling the different Wage Premia (2006)	118
A.2	Robustness 2 - Controlling for Unobserved Heterogeneity	119
A.3	Robustness 3 - Firm Movers	120
C.1	Countries in the Sample	127

Chapter 1

Wage Inequality and the Role of Multinational Firms: Evidence from German Linked Employer- Employee Data

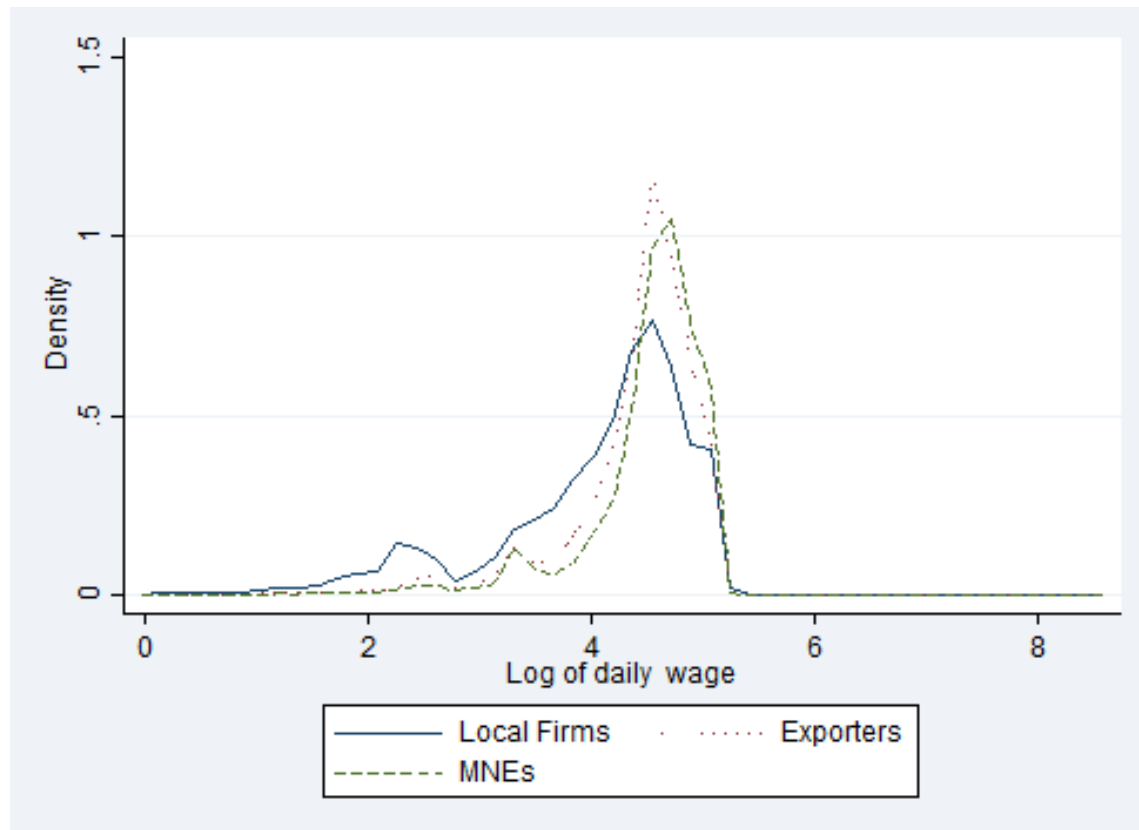
1.1 Introduction

The link between increasing globalisation and wage inequality, has become a central topic in economic analysis and policy debate. It is by now an established fact that exporters pay more for seemingly identical workers - known as the exporter wage premium.¹ At the same time, the recent surge in multinational activity, measured by foreign direct investment (FDI), has broken the link between foreign sales and exports. In fact, the recent growth of FDI has caught up and at times outpaced the growth of trade and income.² This recent development raises the following questions I address in this paper: first, is it exporting per se or multinationals with

¹See for example Bernard et al. (1995), Schank et al. (2007), Verhoogen (2008) and Helpman et al. (2017) for empirical evidence on the exporter wage premium.

²Shatz and Venables (2000), Navaretti et al. (2004) and Antràs and Yeaple (2014) provide some stylized facts concerning recent developments regarding exporting and multinational activity.

exporting activity that contribute to wage inequality between observationally identical workers? Second, how do firms' diverse internationalisation decisions affect the employment structure within a firm and the skills demanded?



Notes: The figure shows the kernel density of the (log) daily wage distribution in 2006, broken down by firm-types, i.e. Local firms, exporters and MNEs. MNEs here include, foreign owned MNEs, domestic MNEs and hybrid MNEs. Statistics refer to all observations in the sample. See Table 1 & 2 for detailed descriptive statistics on individuals and firms. The kernel is Epanechnikov and the kernel width is the Stata default one.

Figure 1.1: Wage density by firm-type

Figure 1 presents the kernel density of the (log) daily wage in 2006 for Germany for three different firm types, where I classify internationalising firms according to two distinct forms of foreign market entry, i.e. exporting vs FDI. This classification enables me to additionally compare wage premia of exporting firms (without FDI activity), with wage premia of multinationals (MNEs) that (potentially) also engage

in exporting activity. A look at the wage densities of local firms, pure exporters and MNEs indicates that firms participating in foreign markets via different modes of market entry pay different wages. This observation suggests that indeed the differentiation between exporters and MNEs is important when studying the implications of diverse forms of globalisation for wage inequality.

This study uses German linked employer-employee data to establish some novel facts about wage and employment differences between firms with diverse international activities. In doing so, this paper is among the first to (1) jointly estimate the exporter and the MNE wage premium and (2) to further distinguish between wage premia of multinational firms that are foreign owned (inward FDI) and domestically owned (outward FDI). My findings exhibit a clear hierarchy of firms' international activities with regard to wage premia and the average workforce ability, where MNEs can be ranked highest. This observed pattern between the ranking of wages and the skills required, suggests worker-firm-type complementarity.

The analysis of this paper is based on linked employer-employee data for Germany (LIAB), which contains detailed information concerning worker and firm characteristics, firms' ownership status, as well as exporting and FDI activity. Information on outward FDI is only available for 2006 and 2010 and hence, limits the analysis to these two sample periods. The fact that the major share of German FDI flows is in the form of outward FDI (OECD (2018)), suggests that, when analysing the MNE wage premium for Germany, it is particularly important to include information on German firms' multinational activity. Germany is an ideal testing ground for this exercise as it is the largest economy in Europe, one of the largest exporting countries, a main recipient and sender of FDI in the international market and it has experienced an increase in (residual) wage inequality in recent decades.³

²This yields the three firm types as shown in the figure: (1) Local firms, i.e. firms with no international activity, (2) 'pure' exporters, which are firms that serve foreign markets via exporting, but do not engage in FDI and (3) MNEs, which are firms with inward/outward FDI and potentially exporting activity.

³Recent findings from the labour literature (e.g. Autor et al. (2008), Dustmann et al. (2009) and Card et al. (2013)), emphasise that there has been a rise in wage inequality within narrowly

In the baseline regression I focus on the cross-sectional data of 2006 in order to shed some light on how observed firm and worker heterogeneity can explain part of the variation in wages. Estimation results of this specification show that pure exporters pay, on average, 1.4% and MNEs 6.5% more for seemingly identical workers. For the representative worker in my sample (in 2006) this implies that he would receive about 1,794 euros extra per year if employed for a MNE.⁴ Because the cross-sectional analysis ignores the possible sorting of workers with higher unobserved ability into specific firm types, I further explore to what extent unobserved worker ability shape my findings. To do so, I make use of the available panel dimension (2006-2010), by adding individual-, firm- and spell fixed effects. After controlling for time-invariant unobserved and observed firm and worker heterogeneity, the exporter premium is about 1.9% and the MNE wage premium 2.5%. The fact that MNE wage premia reduce by relatively more, after controlling for unobserved heterogeneity, is suggestive evidence for assortative matching between firm type and workers on observable unobservable ability. Complementary, the analysis of a sample of firm-movers, examines and compares the wage growth of workers moving to different firm types. The results of the switchers analysis confirms that there are advantages associated with working for internationalising firms. Two distinct findings stand out. First, workers that move from a local to an exporter or MNE experience, on average, larger wage gains relative to workers that move within the same firm type. Second, transitions in the opposite direction, i.e. workers moving away from exporters or MNEs to local firms, experience a wage growth that is significantly lower than the

defined industries and occupations, suggesting that inequality has been rising not only *between* groups, defined by educational categories and/or occupations, but also *within* groups ("residual inequality"). Furthermore, recent studies, such as Song et al. (2015) and Card et al. (2018), have pointed out that this latter type of wage inequality is driven by significant employer-specific wage differentials.

⁴The example of the median worker serves a mere illustrative purpose. The median worker in the sample receives a daily wage of about 105.5 euros per day. Hence, a MNE premium of 6.5% implies that an observationally identical worker receives about 6.9 euros more per day and aggregated to a year with about 260 working days this would be about 1,792 euros extra. Given that the average worker is about 40 years old, all other things equal, he would earn about 44,850 euros more when entering retirement than his 'identical twin' in the local firm.

equivalent wage growth of individuals that move within the same firm type.⁵

To further investigate the sorting pattern between internationally active firms and workers on unobserved skills, I back out the worker fixed effect to obtain a measure of unobserved worker ability. The mean of this worker effect on the firm level helps to identify, whether on average exporters and MNEs have workforces of higher average unobserved skills. A simple OLS regression of the mean unobserved skills per firm on a set of firm characteristics, confirms that workers with higher unobserved ability sort into exporters and even more so into MNEs. Furthermore, I explore the sorting pattern with regard to observed worker skills in terms of educational level and the complexity of tasks performed. The estimation results suggests that exporters and MNEs employ, on average, more skilled workers than local firms. To the extent that unobserved and observed individual characteristics also matter for firm outcomes, these findings suggest that there is a 'skill-internationality' complementarity. I test this hypothesis by further analysing whether exporters and MNEs pay relatively more for different types of workers. In order to perform this test, I include interaction terms between the educational or task level with the firm type. The analysis highlights that MNEs, on average, reward highly educated workers and employees performing highly complex tasks more than local firms and exporters, which is additional evidence for worker-firm-type complementarities in the underlying firm technologies.

Related Literature. More generally, this paper is related to a number of recent studies, which analyse the link between globalisation and wages using firm-level and linked employer-employee data.⁶ The paper Helpman et al. (2017) is closely related to mine for two reasons. First they provide estimates for the exporter wage premium

⁵These findings are in line with Martins (2011), who uses Portuguese matched employer-employee data to study the foreign ownership wage premium. Similar to my analysis, his paper, exploits spells of inter-firm mobility and finds that workers moving from domestic to foreign firms pay systematically more than movers from foreign to domestic firms. His paper, however, may be underestimating the effect of MNEs, as his data does not allow him to distinguish between domestic MNEs and domestic firms with no FDI activity. Moreover, my study investigates the exporter wage premium, which is not part of his analysis.

⁶The paper also contributes to research that investigates the effect of openness on the process of matching between firms and workers, as for example studied by Davidson et al. (2012), Sampson (2014), Bombardini et al. (2015) and Grossman et al. (2017).

of about 18%. The reason their wage premium is larger than both my exporter and MNE wage premium, is probably partly because they use Brazilian manufacturing data and I use German data for 17 different industries. It goes without saying that Germany and Brazil are two countries at very different stages of economic development and hence, comparisons of wage premia between their paper and mine may be less informative. Also, their paper is silent on whether the exporter premium is driven by 'pure' exporters or MNE-exporter, which I distinguish in my analysis. Furthermore, they only report the exporter wage premium for the cross-section of 1994 and do not exploit to what extent unobserved worker abilities matter.

The second reason their paper is closely related to mine, is because they build a theoretical model that is able to explain my empirical findings. The mechanism can be described as follows. Due to complementarities between the firm productivity and the average ability of its workers, firms have an incentive to screen workers to exclude those which fall below the chosen ability-threshold and in so doing, improve the average ability of their workforce. Hence, the model features imperfect assortative matching on unobservables in the labour market, which is in line with my findings. Their theory explains positive exporter premia for employment and wages and predicts imperfect correlations between firm employment, wages and export status. In the second chapter of my thesis, I extend Helpman et al. (2017) to also include FDI activity by multinational firms. By adding multinational activity to the international trade analysis my second chapter enriches our ability to understand how labour market reforms can condition the relationship between diverse aspects of globalisation and labour market outcomes

Apart from papers, which relate to the exporter wage premium (e.g. Bernard et al. (1995) Schank et al. (2007), Verhoogen (2008), and Baumgarten (2013)), my analysis in particular related to a growing literature that aims at measuring and explaining multinational wage premia.⁷ As most studies can not distinguish between

⁷Studies based on firm-level data (e.g. Lipsey (2004) or using linked employer-employee data, such as Heyman et al. (2007), Görg et al. (2007) and Martins (2011) analyse the foreign ownership wage premium. However, the overall implications of these recent studies are not well understood, as

domestically owned and foreign owned MNEs, what has been labeled in the literature as MNE wage premium, usually refers to the foreign ownership wage premium.⁸ Most closely related to my paper is Tanaka (2015), who estimates the MNE wage premium for Japan. To the best of my knowledge, this is the only other paper, using employer-employee data, to jointly estimate the exporter and MNE premium. His study uses the quantile regression technique to reveal the premium in each quantile of the wage distribution. This is a dimension I do not explore. Instead, my paper rather focuses on establishing facts with respect to differences in pay between different firm types and sorting and matching patterns between internationalising firms and workers of different skills.

Moreover, this paper sheds light on the skill and task structure of wage premia by internationalising firms across skill groups and tasks of varying complexity. Previous studies, such as Munch and Skaksen (2008), Baumgarten (2013) and Klein et al. (2013), address this aspect of wage inequality in detail for exporting firms. My analysis is different to these papers in two ways: first, while they focus on the skill structure with respect to educational groups and/or occupations, my paper adds the complexity of tasks performed to the analysis. The German linked employer-employee data set contains information on the task requirement of occupations, which allows me to account for this detail and thus, contributes importantly to the analysis. Second, my analysis includes MNEs.⁹ To the best of my knowledge, the skill and task structure of MNE wage premia has not been investigated empirically with linked employer-employee data.

The remainder of the paper is structured as follows. In Section 2, I introduce the data and provide some descriptive stats as motivating evidence. In section 3 I

the results are qualitatively mixed. Some studies seem to confirm the existence of a MNE (foreign ownership) wage premium and others find insignificant or even a negative effect.

⁸Theoretical contributions in the literature have suggested different mechanisms for the existence of the MNE wage premium. See for example Fosfuri et al. (2001), Glass and Saggi (2002), and Egger and Kreickemeier (2013) Gumpert (2015).

⁹Following Autor et al. (2013), many empirical and theoretical contributions in the labour and trade literature, emphasise that distinguishing between educational level and tasks may be important when measuring the skills demanded by firms.

analyse the different wage premia based on different specifications. Section 4 offers empirical evidence for the skill and task structure of wage premia and employment. Lastly, section 5 concludes.

1.2 Data

1.2.1 Data Description

The analysis is based on matched employer-employee data for Germany, which is provided in the the linked employer-employee data (LIAB) from the Institute for Employment Research (IAB). I focus on the years 2006 and 2010, which are the years where information on exporting and multinational activity is available. The core of this dataset is the IAB establishment panel, which is a representative employer survey of employment parameters at individual establishments. Using a common establishment identifier, administrative worker-level information from the German Federal Employment agency is matched with the survey. See Alda et al. (2005) for an overview of the LIAB data set.

IAB Establishment Panel

The IAB Establishment Panel is a longitudinal survey, i.e. a large majority of the same establishments are interviewed every year. As a result, it enables both analysis of developments across time through comparison of cross-sectional data at different points in time, and also longitudinal studies of individual establishments. It contains about 16,000 establishments in Germany that employ at least one worker who pays social security contributions. As there are about 2.9 million establishments in Germany (in 2014), the IAB Establishment Panel covers roughly 0.55% of all establishments. The survey was launched in western Germany in 1993, with the aim of building up a representative information system for continuous analysis of labour demand. It was extended to eastern Germany in 1996, making it a nation-

wide survey. Establishments in the IAB Panel are surveyed on various employment policy-related subjects, including business policy and business development, employment development, personnel structure, wages and salaries, investment activities and other general data on the establishment. The survey also includes varying focal topics every year. The IAB Establishment Panel is regarded as containing high data quality, achieved by means of the high-quality sample, the high exploitation level and the sophisticated process of data monitoring and error correction. Fischer et al. (2009) provide an in-depth discussion about the sampling methods.

Individual-Level Data

Data on individuals comes from the Integrated Employment Biographies (IEB) of the IAB. The IEB cover all workers, subject to social security contributions. This amounts to about 80 percent of German workers, excluding civil servants, self-employed, family workers and workers in marginal employment. This data includes detailed information on several worker characteristics, such as gender, age, nationality, education, tenure and wage compensation. According to the social security notification regulations, employers ought to report these data at the end of each year, and at the beginning and end of each employment spell. However, because of a reporting ceiling in the German social-security system, wages are right-censored at the contribution limit. The data allows to comprehensively follow individuals over time, including a large number of individuals who switch from one plant in the sample to another one also in the sample.

International Activity and Classification of Firms

At the plant-level, the data comprises information about exporting as well as multinational activity of firms. While information on exporting is available for all

years, information of FDI activity is only available for the years 2006 and 2010.¹⁰ Exporting is measured as the share of sales obtained in export markets. As the LIAB contains variables that can be used as proxies for outward FDI, I am able to distinguish between domestic and foreign owned MNEs. In 2006 establishments were asked whether they had any 'foreign investment in 2004-2005', where foreign investment involves extensive ownership stakes in domestic companies and assets of more than 10%. However, in 2010, establishments are required to report if they have 'current activity abroad (takeover, foundation or equity participation)'. This is a more general question, since equity participation may be less than 10% of the foreign company's asset. As a result, it may be difficult to identify among the firms that switch their firm type between 2006 and 2010, and those that actually changed their mode of foreign market. However, only about 5.6% of all MNEs that are in the 2006 and 2010 panel, switch their status from MNE to non-MNE firm. The percentage of firms switching from non-MNE to MNE between the periods is a bit higher with 27.4%.

Furthermore, I can use the ownership status of the firm to identify foreign owned MNEs. By definition, a firm under foreign ownership is a multinational enterprise. With the information on whether a firm exports and/or is classified as a MNE, we can distinguish between two types of exporting firms. First, 'pure exporters' are exporters that are non MNEs and second, 'hybrids' are MNEs that engage in exporting. The classification of firms is in correspondence to the ownership status (foreign or domestic) and the internationalisation decision (exporting and/or FDI) of the firm, which gives rise to 5 different types of firms:

1. *Local*: firms that are domestically owned and do not participate in international markets.
2. *Exporters*: these are the 'pure' exporting firms, i.e. firms that are domestically

¹⁰Information about the export destination and FDI recipient countries is limited and, thus, cannot be used for the purpose of this study.

owned and serve foreign markets via exporting, but do not report outward FDI.

3. *Domestically owned MNEs*: firms under domestic ownership that report positive outward FDI, but do not export.
4. *Foreign owned MNEs*: are establishments under foreign ownership, without positive exports.
5. *Hybrid*: firms that report positive exports and are MNEs, i.e. either fall into category (3) or (4)

Sample Restriction

The sample includes all firms within the private sector, for which we have information on ownership, industry and size of the workforce (at least 5 employees). On the worker side, I take all individuals into account that are within the working age population, i.e. between 16 and 65 years. Furthermore, I restrict the sample to all fulltime workers where information is available in both sample years.

1.2.2 Descriptive and Non-parametric Statistics

Firm Level Statistics

Table 1 gives the frequency distribution of firms and workers by firm-type for the year 2006. Among 4,779 firms in the sample, 3,086 (65%) are local, 1,090 (21%) are exporters and a total of 603 (13%) are MNEs. Within the category of MNEs only 48 (1.00%) are domestically owned MNEs, 150 (3%) are foreign owned MNEs and 405 (9%) are hybrid MNEs, i.e. firms that export and engage in FDI activity.

With respect to the number of workers by firm-type, we ascertain that the majority (39%) works for exporters, 32% for local firms and about 30% is employed

by MNEs, where 2% work for domestic MNEs, 4% in foreign owned MNEs and 24% in hybrid MNEs. The total number of employees in the 2006 sample is 332,654. Notice that although the percentage share of MNEs accounts for only 13% , these firms employ an over-proportional fraction of the total workforce in the sample. This observation suggests that MNEs tend to be on average larger firms.

Table 1.1: Number of firms and workers by firm-type (2006)

Firm type	No. of firms	%	No. of workers	%
Local	3,086	64.57	105,776	31.80
Exporter	1,090	20.88	128,372	38.59
MNE	603	12.61	98,506	29.61
Domestic	48	1.00	5,133	1.54
Foreign	150	3.14	12,210	3.67
Hybrid	405	8.47	271,386	24.40
Total	4,779	100.00	332,654	100.00

Notes: Analysis based on LIAB data for the year 2006. The sample corresponds to full-time workers between 16 and 65 years of age, where data is available for a set of worker and firm characteristics in both sample periods.

Worker-Level Statistics

Worker-level descriptive statistics of daily wages according to the different firm-types are presented in Table 2. The table indicates that local firms pay the lowest wages, followed by ascending order of exporters, foreign owned MNEs, domestic MNEs and hybrid MNEs. Furthermore, Table 2 summarises some additional worker statistics for the three different firm types, including tenure at the firm (in years), age, and information on the dummies for gender (1 equals woman) and nationality (1 equals foreign).

Figure 1 above shows the kernel density of the (log) daily wage in the 2006 wage

Table 1.2: Firm - Worker Statistics

	Min	Mean	Max	Sd	N
Local					
daily wage	1.03	96.33	212.97	38.77	105776
tenure	0	10.13	31.50	7.41	105776
age	16	41.16	61	9.96	105776
woman	0	0.28	1	0.45	105776
foreign	0	0.04	1	0.20	105776
firm size	5	897.64	13702	11055.461	105776
Exporter					
daily wage	1	105.56	237.77	36.73	128372
tenure	0	12.22	31.5	7.89	128372
age	16	40.66	61	9.87	128372
woman	0	0.16	1	0.34	128372
foreign	0	0.06	1	0.24	128372
firm size	5	9958.35	44494	16949.73	128372
MNE					
daily wage	1.13	115.10	212.05	38.14	98497
tenure	0	11.51	31.52	7.88	98497
age	16	40.63	61	9.59	98497
woman	0	0.17	1	0.34	98497
foreign	0	0.07	1	0.25	98497
firm size	5	2501.34	15096	3700.11	98497
Total					
daily wage	1	105.45	237.77	38.51	332645
tenure	0	11.35	31.50	7.94	332645
age	16	40.81	61	9.82	332645
woman	0	0.20	1	0.40	332645
foreign	0	0.06	1	0.23	332645
firm size	5	4869.153	44494	11488.38	332645

sample for the three main categories of firm-types: Local firms, exporters and MNEs. The figure supports the descriptive evidence from Table 2 that MNEs, on average, pay higher wages than exporters and locals, respectively. Jointly Table 2 and Figure 1, indicate that the differentiation between exporter and MNEs is important when studying the implications of globalisation for wage inequality in Germany.

1.3 The Exporter and MNE Wage Premium

1.3.1 Empirical Methodology - Wage Premia

This section outlines the empirical strategy to analyse the existence and magnitude of the MNE and exporter wage premium. In the baseline regression I focus on the cross-sectional data of 2006 in order to shed some light on how observed firm and worker heterogeneity can explain part of the variation in wages. The subsequent subsection then accounts for unobserved firm and worker characteristics by adding fixed effects to the baseline regression. For this purpose, I explore the panel dimension of the data (2006-2010). This enables us to disentangle the different sources of the wage premia and may highlight potential sorting patterns on unobservables. Complementary, the analysis of a sample of firm-movers, examines and compares the wage growth of workers moving to different firm types.

Baseline Regression Set-Up

Using German linked employer-employee data for the year 2006, I test whether firms that participate in international markets via different modes of market entry (i.e. exporting, FDI or both), pay different wages relative to firms that are only active in the domestic market. I employ an OLS estimation using the following Mincer wage regression

$$\log w_{ij} = d_s + d_o + FTYPE'_j \beta_1 + FSIZE'_j \beta_2 + X'_i \beta_3 + v_{ij}, \quad (1.1)$$

where the index j identifies the firm at which worker i is employed. The dependent variable is the log daily wage $\log w_{ij}$ of individual i ; d_s and d_o denote sector and occupation fixed effects; the categorical variable $FTYPE_j$ indicates the firm type, i.e. *Local*, *Exporter*, *MNE_{For}*, *MNE_{Dom}* and *Hybrid*. $FSIZE_j$ controls for the size of the firm, measured by the log size of the firm’s workforce, X_i is a vector of observable worker characteristics and v_{ij} is a residual. The coefficients of interest are contained in the vector β_1 , which captures the wage premia the different firm types pay, i.e. an exporter wage premium and premia for working for any of the three types of MNEs (domestic MNEs, foreign owned MNEs and hybrid MNEs). Moreover, β_2 represents the employment size wage premium.

The five different firm types follow the classification as outlined in section 2.1. Furthermore, I control for worker observables nonparametrically, including, gender, age, nationality (foreign or not), education (low, medium, high), occupation and tenure at the firm.

Extended Specification

The cross-sectional analysis ignores the possible sorting of workers with higher unobserved ability into specific firm types. In order to account for time invariant unobserved worker and firm heterogeneity, I estimate a regression of log daily wages on worker and firm observables, including worker, firm or a unique worker–firm combination (spell) fixed effects. In the labour literature this method is known as the AKM decomposition (Abowd et al. (1999)). For this estimation, I use the available data for 2006 and 2010. I next extend the baseline regression in (1) to exploit the panel dimension of the data. The adjusted OLS mincer wage estimation is then given

¹⁰The survey questions in 2006 and 2010 on foreign investment determine the number of domestic MNEs in each year; given that the fraction of domestic MNEs is rather small (0.81%) and assuming that a firm type is stable over the short sample period, I have a sample ranging from 2006-2010.

by

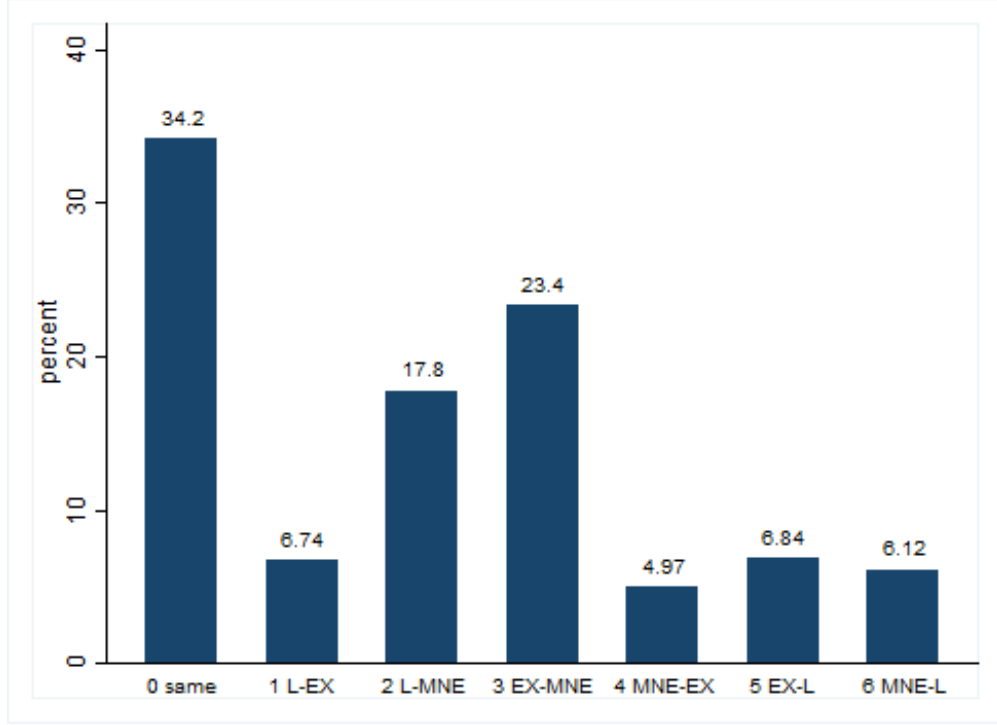
$$\log w_{ijt} = d_s + d_o + FTYPE'_{jt}\beta_1 + FSIZE'_{jt}\beta_2 + X'_{it}\beta_3 + \mu + \alpha_i + \psi_j + v_{ijt} \quad (1.2)$$

again firms are indexed by j and workers by i and $\log w_{ijt}$ is the log daily wage worker i employed by firm j at time t . This estimation now includes a year fixed effect μ , an individual fixed effect α_i and an establishment fixed effect ψ_j . Introducing worker fixed effects allows me to address the issue of workers sorting on unobserved ability into specific firm types. A firm fixed effect controls for time-invariant firm characteristics. The fixed effects method implies that identification of the firm type coefficient (β_1) is driven only by those workers who move to firms of a different type between the two sample periods, or by firms which switch type. Moreover, for this specification I aggregate the three different MNE firm types together as I am going to focus on the difference in pay between local firms, exporters and MNEs as a whole.

Firm-Type Switchers

Another way to test whether there is a positive association between wages and firms' international activity is to analyse a panel of workers moving to different firm types. If it is the exporter/MNE status that matters then we should expect to see that (conditioning for firm size and other firm characteristics) the wage growth for workers who move from local to exporters/MNEs to be different to the wage growth for those who move in the opposite direction or remain within the same firm type. Figure 2 presents the relative frequency of different types of movers that will be the basis of this analysis: Firstly, workers that move to another firm but remain in the same firm type, including local to local (LL), exporter to exporter (EE) and MNE to MNE (MM) switchers. I denote these movers as *Same*-switchers. Second, individuals that switch to and from local firms: Local to exporter (LE), local to MNE (LM), exporter to local (EL) and MNE to local (ML). Third, workers switching between exporter and MNEs, namely exporter to MNE (EM) and MNE to exporter (ME)

switchers.



Notes: The figure shows the relative frequency of firm type switchers. Switchers are defined as workers, who move between 2006 and 2010 to a new establishment, where (0) Same is the reference group and refers to individuals moving within the same firm type, i.e. local to local, exporter to exporter or MNE to MNE; (1) are local to exporter movers, (2) local to MNE, (3) exporter to MNE (4) MNE to exporter, (5) exporter to local and (6) MNE to local. Statistics refer to the sample of movers, where data is available in both periods, based on LIAB data. The sample corresponds to full-time workers between 16 and 65 years of age.

Figure 1.2: Relative Frequency of Firm-type Switchers

The question I address is as follows: how much do wages change when a worker moves to a different firm type? To facilitate the dynamic benefits and losses of moving to different firm types, I subsequently estimate the following specification with firm switchers (*SWITCH*), where I now consider wage growth ($\Delta w_{ij} = \log w_{ij,2010} -$

$\log w_{ij,2006}$) as the dependent variable:

$$\begin{aligned}\Delta w_{ij} = & \psi_j + d_s + d_o + FTYPE'_j\beta_1 + FSIZE'_j\beta_2 \\ & + \Delta FSIZE'_j\beta_3 + SWITCH'_j\beta_4 + X'_{it}\beta_5 + v_{ij}\end{aligned}\tag{1.3}$$

where again the index j identifies the firm at which worker i is employed. As in the previous specifications, d_s and d_o denote sector and occupation fixed effects; the categorical variable $FTYPE_j$ indicates the firm type, i.e local, exporter or MNE. Additional to the the size of the firm ($FSIZE_j$), I control for the change in firm size ($\Delta FSIZE_j$) between 2006-2010. X_i is the vector of time-varying observable worker characteristics, including age, education tenure and occupation and v_{ij} is a residual. The firm fixed effect ψ_j accounts for unobserved firm heterogeneity. The main coefficient of interest is now the vector β_4 , which captures the difference in pay between the different firm-type switchers. The reference group are the *Same*-switchers, i.e. workers that move firm but remain within the same firm type. Unlike in the panel estimation, this specification relies on a sample of firm movers only, which enables me to control for the possibility that there is a difference between workers who switch and workers who stay within the same firm type.

1.3.2 Estimation Results - Wage Premia

Baseline Results

Table 3 summarises the estimation results based on five different types of wage regressions, which differ with respect to the controls included at the right hand side. The first regression in column 1, captures the 'raw' difference in pay between the different firm types, excluding any further controls for firm or worker characteristics. The wage premia can consequently be interpreted as follows: Firms that serve foreign markets by exporting only, pay on average, 11.7% higher wages than local firms. Foreign MNEs, domestic MNEs and hybrids, on average, pay a premium of 18.3%,

17.2% and 21.9%, respectively. Not surprisingly, this reduced form regression has a very low adjusted R^2 of 0.035.

Table 1.3: Unravelling the different Wage Premia (2006)

	(1)	(2)	(3)	(4)	(5)
	No Controls	+Size	+Industry	+Occ	+obs
<i>Exporter</i>	0.117*** (0.00181)	-0.00797*** (0.00178)	0.00954*** (0.00216)	0.0208*** (0.00189)	0.0138*** (0.00165)
<i>MNE_{For}</i>	0.185*** (0.00417)	0.116*** (0.00390)	0.0914*** (0.00396)	0.0987*** (0.00341)	0.0826*** (0.00299)
<i>MNE_{Dom}</i>	0.173*** (0.00623)	0.103*** (0.00583)	0.111*** (0.00584)	0.0239*** (0.00499)	0.0384*** (0.00436)
<i>MNE_{Hyb}</i>	0.215*** (0.00203)	0.106*** (0.00196)	0.117*** (0.00235)	0.0721*** (0.00205)	0.0744*** (0.00180)
<i>log size</i>		0.0881*** (0.00034)	0.0802*** (0.00042)	0.0741*** (0.00038)	0.0667*** (0.00045)
Observations	332,645	332,645	332,645	332,645	332,645
Firms	4,779	4,779	4,779	4,779	4,779
R^2	0.035	0.158	0.188	0.430	0.565

Notes: Regressions based on LIAB data for the year 2006. The sample corresponds to full-time workers between 16 and 65 years of age, where data is available in both sample periods. Dependent variable is the log daily wage. Firm variables include the firm type (local, exporter and 3 different MNEs), the log of employment (size) and 17 industry categories. Worker observables include: gender, age, nationality (dummy for foreign), tenure at the firm, 340 different occupations and the educational level. The education groups are defined as: 1) low: no vocational training, no high-school; 2) medium: high school and/or vocational training; 3) high: university or technical college. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The second specification (see column 2) adds the log of the total number of employees to the regression. Consistent with a large empirical literature in labour eco-

nomics, larger firms on average pay higher wages (see e.g. Brown and Medoff (1989) and Oi and Idson (1999) for surveys). The coefficient for the log of employment is given by 0.088, implying that an increase in employment by one percent, increases the wage rate by about 0.088 percent. As MNEs and exporting firms tend to be larger than local firms, the coefficients for the different firm types decrease. Note, however, that after controlling for the size of the firm, the coefficient for exporters is negative, implying a negative exporter premium of -0.8%. As documented by Felbermayr et al. (2014) the exporter wage premium in Germany is non-monotonic, with firms with medium-sized export shares paying the largest premium. Note as well that I classify exporters in a more narrow way than previous studies, who would include hybrid-MNEs, i.e. firms that engage in FDI and exporting activity into their 'exporter' category. This, together with the fact that I do not control for firms' export shares, might explain the negative, yet very small coefficient after controlling for the size of the firm. The coefficients for the different MNEs become more similar to one another, but remain with on average 11% still relatively large. Similarly, the small increase of the adjusted R^2 to 0.158, suggests that some of the observed differences in pay of exporters and MNEs, relative to local firms (see column 1), can be explained by the size of the firms.

The results in column 3 and 4 are based on a regression that further includes industry and occupation fixed effects, respectively. The exporter premium now becomes positive again, implying that industry and occupation characteristics are strongly enough correlated with the export status to reestablish a positive premium of about 2.8%. The decrease in the coefficients for the different MNEs under these specifications suggests that the difference in pay between the different firm types, as captured in column 1, are mainly due to specific industry and occupation characteristics. This result implies that MNEs belong to high-wage industries and/or have a larger share of high-paying occupations. The strong increase of the adjusted- R^2 to now 0.430 in column 4 confirms this finding. Thus, after controlling for firm-size, industry and occupation fixed effects, the exporter wage premium is still about 2.8%

and that of MNEs on average about 7.5%.

The last specification, presented in column 5, adds the vector X_i of worker characteristics, including gender, age, nationality (dummy for whether worker is foreign), education and tenure at the firm, to the regression. As expected, adding worker observables further raises the adjusted- R^2 , now taking a value of 0.565. However, the coefficients for the different firm types change very little relative to the previous specification with industry and occupation fixed effects. More precisely, the exporter wage premium reduces to 1.4% and for foreign owned MNEs, domestic MNEs and hybrids to 8.2%, 3.7% and 7.3%, respectively. The coefficients of the different firm-types are statistically significant at the 1% in all four specifications. Furthermore, the MNE and exporter premium are significantly different from one another.

In summary, estimations based on this cross-sectional analysis show that even after controlling for firm-size, industry, occupation and worker characteristics, firms with international activities, on average, pay higher wages than local firms. Furthermore, the wage premium paid by MNEs is larger than the exporter wage premium. Among MNEs, firms that export *and* engage in FDI, pay the highest wage premia, followed by MNEs that are foreign owned.

Results from Panel Regressions

Table 4 summarises the estimation results of equation (2). The first three specifications capture three different conventional models, as each controls for heterogeneity from only one side of the market, at best. The fourth specification includes both sets of time-invariant heterogeneity through a spell fixed effect. The idea here is to assess the extent to which estimates on the firm-type are affected by worker- and firm-level covariates. This allows me to assess to what extent time-invariant unobserved worker and firm characteristics are correlated with the firm-type. Firm type coefficients remain significant at the 1% level for all specifications and coefficients

for exporters and MNE status are significantly different from each other.¹¹

Table 1.4: Controlling for Unobserved Heterogeneity

	(1)	(2)	(3)	(4)
<i>Exporter</i>	0.0299*** (0.000877)	0.0206*** (0.000958)	0.026*** (0.00165)	0.0191*** (0.000932)
<i>MNE</i>	0.0492*** (0.000932)	0.0269*** (0.00104)	0.0161*** (0.00181)	0.0250*** (0.00102)
<i>log size</i>	0.0692*** (0.000232)	0.0332*** (0.00109)	0.0463*** (0.00181)	0.0259*** (0.00102)
Individual FE		x		
Firm FE			x	
Spell FE				x
Time FE	x	x	x	x
Worker controls	x	x	x	x
Firm controls	x	x	x	x
Observations	665290	665290	665290	665290
Firms	5,490	5,490	5,490	5,490
R^2	0.430	0.574	0.456	0.579

Notes: Regressions based on LIAB data for the year 2006 and 2010. The sample corresponds to full-time workers between 16 and 65 years of age, where data is available in both sample periods. Dependent variable is the log daily wage. See notes of table 3 for the set of firm and worker observables. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The first column captures the results of a simple pooled ordinary least squares (POLS) estimation including year fixed effects. This estimation confirms the findings

¹¹In the Appendix A provide results for the panel regression with the more detailed classification of MNEs.

presented in Table 3 that MNEs pay higher wage premia than exporters. Note, however, that relative to the numbers from the cross-sectional analysis, the premium for exporters has now increased slightly, taking a value of 2.9% and the equivalent coefficient for MNEs has decreased from about 8% to 4.9%.

The second column shows the results for the individual fixed effect regression, which takes care of unobserved worker heterogeneity, such as ability, productivity, social competence, networks and so forth. The increase in the R^2 from 0.487 to 0.574, indicates that unobserved characteristics of workers, captured by individual fixed effects, contribute to the variance of log wages. This is also reflected in lower wage premia for exporters and MNEs, where the coefficient for MNEs reduces by relatively more, suggesting a potentially stronger correlation between worker unobservables and MNE status.

The third column includes firm fixed effects to control for time-invariant unobserved firm heterogeneity. The results of this regression, however, have to be interpreted with caution. One potential limitation is that there may be only little variation in the firm-type variable during this relatively short period of 4 years (2006-2010). Furthermore, variation in firm-types, may not be caused by actual changes in the way firms participate in international activity, but may be due to the fact that the survey questions concerning outward FDI vary slightly in the two given years.¹² This caveat may affect the estimated coefficient for exporter and MNE wage premia. Keeping this caveat in mind, the table reports that after controlling for unobserved characteristics of employers, captured by employer fixed effects, the exporter wage premium (2.6%) is now larger than the premium paid by MNEs (1.6%). The low value of the R^2 , relative to the other specifications, suggest that firm fixed effects on their own contribute little to the variance of log wages.

¹²In 2006 establishments were asked whether they had any 'foreign investment in 2004-2005'. In 2010 the question is formulated in a more general sense, whether they have 'current activity abroad (takeover, foundation or equity participation)'. Foreign investment involves extensive ownership stakes in domestic companies and assets of more than 10%. Whereas, the question in 2010 refers to equity participation in general, which may be less than 10% of the foreign company's asset.

Combining worker fixed effects and firm fixed effects (see column 4) through a spell fixed effect, accounts for unobserved match-specific heterogeneity. A potential source of match heterogeneity in wages is complementarity between the skills of the worker and the needs of the firm. To the extent that the individual worker has significant bargaining power, this complementarity will be rewarded in the form of higher wages. Concerning the validity of the coefficients, however, the same caveats hold as were the case for the firm fixed effects specification: within-group variation may be a noisy measure of true firm-type changes. Under this last specification, MNEs on average, pay the highest wages with a premium of 2.5% and the exporter premium is 1.9%. Under this last specification the R^2 takes the highest value of 0.580.

In summary, after including worker fixed effects the exporter and MNE wage premia reduce significantly, implying that unobserved worker characteristics are positively correlated with firms' international activities. Additionally, taking results from the spell fixed effects regression into account, gives suggestive evidence for complementarities between (unobserved) worker skills and firm technologies.

Results: Firm-Type Switchers

Table 5 presents the estimation results of the switchers regression. The first column shows the results for the OLS regression and the second column presents the results after controlling for unobserved firm heterogeneity. The estimated switcher dummies seem to confirm the hypothesis stated above, i.e. workers moving from a local firm to a firm that participates in international activities, experience, on average, a larger wage gain than workers moving within the same firm type. Focusing on the firm fixed effects specification in column 2 shows that workers that switch from a local firm to an exporter (LE) receive a mobility premium of about 17.6% and local to MNE movers (LM) 30.1% respectively.

Table 1.5: Analysing Firm-Type Switchers

	(1)	(2)
	POLS	Firm-FE
<i>Exporter</i>	-0.165*** (0.0345)	
<i>MNE</i>	-0.227*** (0.0289)	
1 L-EX	0.0969** (0.0373)	0.176** (0.0604)
2 L-MNE	0.295*** (0.0260)	0.308*** (0.0316)
3 EX-MNE	0.113*** (0.0241)	0.0587 (0.0306)
4 MNE-EX	0.000276 (0.0393)	-0.0489 (0.0619)
5 EX-L	-0.206*** (0.0323)	-0.313*** (0.0473)
6 MNE-L	-0.148*** (0.0324)	-0.368*** (0.0487)
$\Delta \log size$	-0.0572 (0.0508)	0.0818 (0.0611)
Observations	7302	7302
R^2	0.208	0.210

Notes: Dependent variable is the change in the log daily wage. Controls include firm-type, 7 switcher types (see Figure 2), log of employment size in levels and changes, industry, age tenure and education. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Contrary, movers in the opposite direction experience, on average, wage changes that are lower than that of *Same*-switchers.¹³ For workers moving from an exporter to a local firm (*EL*) the average wage change is about 31,3% lower and that of *ML* switchers about 36.8% respectively. Note, that the disadvantages from moving away from exporters or MNEs are larger than the advantages from a transition to one of these firm-types. One explanation for this finding could be that separations and the direction of the transition is endogenous and may capture some underlying sorting patterns. Additional worker and match-specific fixed effect would be a way to control for this. However, it is not possible to include worker fixed effects into the specification, where the dependent variable is the change in the log of the wage, as the panel includes only two time periods.

All coefficients, apart from the one for the *LE* switchers, are significant at the 1% level. The *LE* coefficient is significant at the 5% significance level. The coefficients for movers that switch among Exporters and MNEs are relatively small compared to the ones described for the other switchers; the coefficients for *ME* and *EM* switchers are not significant.

It should be noted that the estimated coefficients capture static and dynamic advantages of switching to a particular firm type, i.e. there may be first a jump in the wage the moment the worker switches firm type and additionally, dynamic advantages associated with working within a particular firm type, such as learning by working for a MNE. Given the relatively short sample period (2006-2010), the coefficients can only be interpreted as capturing the static and dynamic advantages within this time frame, and do not take wage changes beyond this period into account. This would be of particular interest to test whether e.g. wage growth exhibits a u-shaped pattern after moving firm type.

Summing up, the results of the switchers analysis highlights two distinct findings:

¹³Table A.3 in the Appendix presents estimation results based on a regression as in equation (2), additionally controlling for whether a worker moved during the sample period. Based on a simple POLS estimation firm-movers earn on average 3.8% less and the firm fixed specification suggests that movers are being paid about 7% less relative to stayers.

First, workers that move from a local to an exporter or MNE experience, on average, larger wage gains relative to workers that move within the same firm type. Second, transitions in the opposite direction, i.e. workers moving away from exporters or MNEs to local firms, experience a wage growth that is significantly lower than the equivalent wage growth of individuals that move within the same firm type.

1.3.3 Robustness Checks

In this section, I consider the robustness of my results to different subsamples of the data set and by further analysing differences in the wage premia among MNEs.

In the Appendix, Table A.1. presents estimation results equivalent to the ones in Table 3, where I include workers that may only appear in the sample in 2006. Consequently, the sample corresponds to full-time workers between 16 and 65 years of age, where data is available at least in 2006. The qualitative interpretation of the different firm type coefficients only changes with respect to the second column, which adds the firm size to the regression: The exporter premium is now positive at the 1% significance level.

Additionally, I present estimation results for the different wage premia equivalent to Table 4, using a sample excluding all firms that switch their type between 2006 and 2010. This addresses the concern regarding the varying survey questions on outward FDI in the two sample periods.¹⁴ Table A.2 in the Appendix summarises the results.

Table A.3 presents estimation results based on a regression as in equation (2), additionally controlling for whether a worker moved during the sample period. As shown in the table, based on a simple POLS estimation firm-movers earn on average 9.2% less and the firm fixed specification suggests that movers are being payed about 9% less relative to stayers. One potential explanation for this finding could be that movers had some unemployment spell between moving from one firm to

¹⁴See discussion related to estimation results of Table 4

another. Another reason that might explain why movers earn less on average may be that these workers accept a lower starting wage at another firm in exchange of a steeper wage profile during their time at the new firm. Alternatively, incentives may be going the other way: because movers are dissatisfied with their low wages they move to a different firm, with the expectation of receiving more at another firm.

1.4 The Skill and Task Structure of Wage Premia and Employment

The above analysis gives suggestive evidence for the presence of complementarities between (unobserved) worker ability and firm types: First, results from the fixed effects estimation in section 3.2 pointed out that unobserved worker and firm heterogeneity are important factors in explaining some of the variation in wages among observationally identical individuals. Moreover, I show that wage premia reduce after controlling for worker and spell fixed effects and that MNE wage premia reduce relatively more. These results are indicative for positive assortative matching between worker and firm type. In this section I will further investigate the sorting patterns between internationally active firms and workers on unobserved and observed worker skills.

1.4.1 Workforce Composition

Unobserved Skills

In order to test whether and to what extent workers with higher unobserved ability sort into internationalising firms, I will employ the following empirical approach: First, the estimated individual fixed (see equation (2)), can be used as a measure of the unobserved ability of the worker. This may include a worker's productivity, language skills and other characteristics that are not available to the econometrician.

Second, using the mean of these unobserved abilities on the firm-level, I will then employ the following OLS firm-level regression for the 2006 cross-section:

$$\phi_j = d_s + FTYPE'_j\beta_1 + FSIZE'_j\beta_2 + X'_m\beta_3 + v_j \quad (1.4)$$

where ϕ_j is the mean of the unobserved worker ability in firm j and the firm controls are as before, an industry fixed effect (d_s), firm size ($FSIZE$) and the firm type ($FTYPE$). The vector X_m aggregates several worker characteristics up to the firm level, i.e. the share of foreign and female workers and the average age and tenure of workers in the firm.

The estimation results confirm our inference from the previous section, namely that workers with higher unobserved ability sort into exporters and even more into MNEs. There are several potential explanations for the observed sorting pattern between firm types and unobserved worker skills. Intuitively, some skills and types of knowledge are going to be more valuable to firms that are internationally active, such as language skills, working in larger and more heterogeneous teams, leadership ability etc. To the extent that unobserved individual characteristics also matter for firm outcomes, the results from Table 6 suggest there is a 'skill-internationality' complementarity.

In a similar fashion to Table 3, Table 6 summarises the estimation results based on different types of wage regressions, which differ with respect to the controls included at the right hand side. The estimated coefficients in column 4, based on a specification including all firm controls, suggest that exporters and MNEs employ,

¹⁴Previous research from the labour literature has already provided evidence for the importance of assortative matching, as measured by the correlation between individual and establishment effects, for sorting patterns wage inequality (see for example Shimer and Smith (2000), Rogerson et al. (2005) and Chade et al. (2017) for reviews of the search and matching literature). Here, I am interested in the correlation between the individual fixed effect and a specific firm characteristic, namely the firm type.

¹⁴For example, we would think that communication and language skills are more valuable to firms, who are internationally active by developing relationships with customers and business partners abroad.

Table 1.6: Sorting Patterns - Unobserved Ability and Firm Types (2006)

	(1)	(2)	(3)	(4)
	No Controls	+Size	+Industry	+Obs
<i>Exporter</i>	0.0768*** (0.0162)	-0.0056 (0.0160)	0.0860*** (0.0171)	0.0702*** (0.0156)
<i>MNE</i>	0.256*** (0.0205)	0.0873*** (0.0211)	0.170*** (0.0215)	0.129*** (0.0199)
<i>log size</i>		0.0932*** (0.00434)	0.0798*** (0.00436)	0.0551*** (0.00410)
Firms	4,779	4,779	4,779	4,779
R^2	0.033	0.188	0.194	0.340

Notes: Table presents regression results based on a firm-level sample, with the average unobserved skill per firm as dependent variable. I construct the measure of unobserved worker ability by backing out the individual fixed effects of a regression of log individual wages as in specification (2). I then take the average of the obtained worker fixed effect on the firm level. Firm controls include industry, firm size, and the firm type. Worker characteristics are averaged on the firm level, i.e. the share of foreign, female and high skilled workers and the average age and tenure of workers in the firm. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

on average, workers with higher unobserved characteristics than local firms. The coefficient for exporters takes a value of 0.0138 and for MNEs 0.0826, respectively. The estimated coefficients in all specifications are significant at the 1% and the exporter and MNE coefficient are significantly different from each other in all estimations. Furthermore, the positive coefficient for firm size (0.0667) indicates that larger firms have, on average better workers with respect to their unobserved component of skills.

Observed Skills

In addition to providing evidence for positive assortative matching between firm type and unobserved worker ability, I will further explore the sorting pattern with regard to observed worker skills in terms of educational level and the complexity of tasks performed. Following Autor et al. (2008), many empirical and theoretical contributions in the labour and trade literature, emphasise that distinguishing between educational level and tasks may be important when measuring the skills demanded by firms. A higher demand for skills, in turn, may capture underlying features of the production process, such as complementarities between firm productivity and worker ability

The three educational groups are defined as follows: the first category captures workers with a 'low' educational level, who at most have a high-school diploma and no vocational training. The second group refers to workers with a medium level of education, i.e. with a high-school diploma at most and vocational training or "Abitur" qualification for university entrance without vocational training or "Abitur" qualification for university entrance with vocational training. Respectively, the group with a high level of education has a university diploma or a technical college diploma.

Furthermore, I investigate differences in the task structure between different firm types. Here, the formal qualification of the person practicing the occupation is irrelevant; the subject of consideration is rather the requirement level that is typically demanded for this occupational activity. The objective of classifying occupations according to their complexity is to be able to depict the various degrees of complexity within those occupations which have a high similarity of occupational expertise. This need not be based on the educational level, but can also be acquired through work experience and learning-by-doing. I distinguish between three levels to map the degree of complexity of an occupation: (1) unskilled/semiskilled task, (2) skilled task, (3) complex task.¹⁵

¹⁵See Appendix for a description of the classification of occupations according to their task complexities.

Methodologically, I will estimate a regression similar to the one in equation (4). The dependent variables for the two specifications of interest, are the share of high-skilled workers and the share of workers performing complex tasks. Table 7 and 8 summarise the estimation results equivalent to the one for unobserved worker skills in Table 6.

Table 1.7: Share of High Skilled Workers (2006)

	(1)	(2)	(3)	(4)
	No Controls	+Size	+Industry	+Obs
<i>Exporter</i>	0.0198*** (0.00331)	0.0124*** (0.00338)	0.0261*** (0.00355)	0.0259*** (0.00353)
<i>MNE</i>	0.0589*** (0.00418)	0.0438*** (0.00447)	0.0552*** (0.00445)	0.0568*** (0.00443)
<i>log size</i>		0.0083*** (0.0009)	0.0061*** (0.00090)	0.0072*** (0.00092)
Observations	4779	4779	4779	4779
R^2	0.042	0.058	0.176	0.192

Notes: Table presents regression results based on a firm-level sample, with the share of high skilled workers in a firm as dependent variable. Firm controls include industry, firm size, and the firm type. Worker characteristics are averaged on the firm level, i.e. the share of foreign and female workers and the average age and tenure of workers in the firm. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The estimated coefficients in column 4 of Table 7, based on a specification including all firm controls, suggest that exporters and MNEs employ, on average, more skilled workers than local firms. The coefficient for exporters takes a value of 0.0259 and for MNEs 0.0568, respectively. The estimated coefficients in all specifications are significant at the 1% and the exporter and MNE coefficient are significantly different

from each other in all estimations.

This observed sorting pattern, i.e. the fact that more skilled workers match with firms that participate in global markets, provides further supportive evidence for the hypothesis regarding worker-firm-type complementarities. Furthermore, this finding is in line with theoretical and empirical predictions from the search and matching literature, where sorting arises due to complementarities in the production technology of the firm (e.g. Bagger and Lentz (2014) Eeckhout and Kircher (2018) and Lopes de Melo (2018)). As has been pointed out by Eeckhout and Kircher (2011), wages can give information about the strength of sorting, which is consistent with the result that MNEs pay higher premia for high skilled workers.¹⁶ The same analysis can be carried out for the share of workers performing complex tasks. The estimation results in Table 8 are in line with the discussion concerning the share of high skilled workers: exporters employ, on average, more workers performing complex tasks than local firms, as captured by the significant and positive coefficient of 0.0263. The respective coefficient for MNEs takes a value of 0.0784, implying that MNEs, on average, have the highest share of occupations that are of complex task content.

1.4.2 Wage Premia across Skill Groups and Task Levels

The above analysis suggests that there is a skill-internationality complementarity. In the presence of complementarities we would expect that MNEs and exporters pay more for workers with higher skills. Furthermore, I explore whether different firm types reward workers, performing tasks of varying complexity differently.

Differences in pay by educational group

In order to analyse whether exporters and MNEs pay relatively more for different types of workers, I will next run a regression as in (1) with an additional interaction

¹⁶However, Eeckhout and Kircher (2011) argue, from wage data alone, one cannot distinguish a model that features positive sorting from a model of negative sorting, due to non-monotonic relationship between wages and firm type.

Table 1.8: Share of Workers performing Complex Tasks (2006)

	(1)	(2)	(3)	(4)
	No Controls	+Size	+Industry	+Obs
<i>Exporter</i>	0.0122* (0.00487)	0.000146 (0.00497)	0.0267*** (0.00501)	0.0263*** (0.00496)
<i>MNE</i>	0.0733*** (0.00616)	0.0486*** (0.00657)	0.0759*** (0.00628)	0.0784*** (0.00624)
<i>log size</i>		0.0136*** (0.00135)	0.0091*** (0.00128)	0.0105*** (0.00130)
Observations	4779	4779	4779	4779
R^2	0.029	0.049	0.233	0.251

Notes: Table presents regression results based on a firm-level sample, with the share workers performing complex tasks in a firm as dependent variable. Firm controls include industry, firm size, and the firm type. Worker characteristics are averaged on the firm level, i.e. the share of foreign and female workers and the average age and tenure of workers in the firm. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

term between the firm type and the educational variable.

Column 1 of Table 9, presents the estimation results. The interpretation of the coefficients is then as follows: The coefficient of the educational variable is the expected effect of being a medium/high skilled worker among the non-international firms, i.e. the difference in pay between a low and medium (25%) or low and high (41.7%) educated worker, where both are employed by local firms. The coefficients of the interaction between firm type and the educational variable, gives the differential effect of a particular worker type being employed by a different firm type. The effect of being employed by an exporter, relative to a local firms, is 7.35% for low-, 0.34% for medium- and 0.32% for high educated workers. The respective effect for MNEs is 11.4% for low-, 6.97% for medium- and 5.12% for high educated workers. The coeffi-

cient for a medium skilled worker in an exporter is significant at the 10% significance level, all other coefficients are significant at the 1% level.

These results suggest that MNEs, on average, reward workers across all skill types more than non-international firms, whereas the effect for exporters is either low or not significant. This finding nuances the results regarding firms' employment structure and worker-firm-type complementarities. MNEs have a workforce of a higher average ability, which receives higher wages across all educational groups, which confirms the hypothesis concerning skill-internationality complementarity. The workforce of exporting firms is, on average, more skilled than the workforce of local firms. However, in terms of wages more skilled workers employed by exporting firms do not have an advantage relative to their domestic counterparts.

Differences in pay by task requirement

Column 2 of Table 9 captures the results of regressions with the interaction of the firm type with the variable measuring the complexity of tasks performed. The interpretation of the coefficients follows the same logic as above for the interaction with the educational variable. All estimated coefficients in this specification are statistically significant at least at the 5% level.

The coefficient of the task complexity variable is the expected effect of a worker in a skilled, complex or highly complex task among the non-international firms, i.e. the difference in pay between an unskilled and skilled (13.3%), unskilled vs complex (65.4%), where workers are employed by local firms. The differential effect of being employed by an exporter, relative to a local firms, is 3.3% for unskilled-, 1.2% for skilled-, 1.0% for complex. The respective effect for MNEs is 9.5% for unskilled-, 7.4% for skilled- and 7.2% for complex tasks. The estimation results provide a more detailed picture of what type of task is particularly rewarded by different firm types: MNEs pay relatively more for each task performed, while the respective exporter coefficients are smaller for all task types. The results in section 3 indicated that both unobserved and observed worker characteristics are important factors in

Table 1.9: Wage Premia by Education and Task Level

	(1)	(2)
	Education	Task performed
level		
<i>medium</i>	0.2503*** (0.00293)	0.141*** (0.0287)
<i>high</i>	0.417*** (0.00446)	0.650*** (0.0528)
type#level		
<i>Exp#low</i>	0.0735*** (0.00362)	0.0334*** (0.00942)
<i>Exp#medium</i>	0.0038* (0.00178)	0.0092*** (0.00158)
<i>Exp#high</i>	0.0032 (0.00424)	0.0075 (0.00424)
<i>MNE#low</i>	0.1140*** (0.0384)	0.0929*** (0.00941)
<i>MNE#medium</i>	0.0697*** (0.00183)	0.0707*** (0.00192)
<i>MNE#high</i>	0.0512*** (0.00416)	0.0694*** (0.00429)
log <i>size</i>	0.0669*** (0.00035)	0.0675*** (0.00038)
Observations	332,645	289,713
R^2	0.565	0.514

Notes: Dependent variable is the log daily wage. Controls included are the interaction between the firm type and the educational variable (low, medium, high) in column 1 and interaction terms between the firm type and the level of complexity of tasks performed (low, medium, high), as presented in column 2. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

driving differences in pay across the different firm types. Table 10 provides a more nuanced picture of which type of firm rewards different worker types more. The analysis highlights that MNEs, on average, reward highly educated workers and employees performing highly complex tasks more than local firms and exporters. which is additional evidence for worker-firm-type complementarities in the underlying firm technologies.

1.5 Concluding Comments

Using German linked employer-employee data, this study provides empirical evidence for the wage premium of exporters and multinational enterprises. I find that, even after controlling for observed and unobserved firm and worker heterogeneity, firms participating in global markets pay higher wages than firms that operate only in the domestic market, where MNEs pay higher premia than exporters. In particular, estimation results from the regression including individual and match-specific fixed effects, seem to confirm some degree of assortative matching on unobserved worker characteristics.

Furthermore, I explore the sorting pattern with regard to unobserved and observed worker skills in terms of educational level and the complexity of tasks performed. The estimation results suggest that exporters and MNEs employ, on average, more skilled workers and a larger share of workers with better unobserved ability. To the extent that unobserved and observed individual characteristics also matter for firm outcomes, these findings suggest that there is a 'skill-internationality' complementarity.

In summary, my findings exhibit a clear hierarchy of firms' international activities with regard to wage premia and the average observed and unobserved workforce ability, where MNEs can be ranked highest. This observed pattern between the ranking of wages and the skills required, suggests worker-firm-type complementary.

Traditionally, exporter and MNE premia have been interpreted as wage differ-

ences received by "identical" workers at different types of firms. My results show that unobserved worker ability varies across the different firm types in a systematic way. This suggests that these workers may not be identical after all and that there are reasons to believe that the observed sorting pattern on unobserved ability, especially prevalent in MNEs, is not mere coincidence. Potentially, MNEs are better at identifying econometrically unobserved talent? This merits further empirical and theoretical investigation. In the second chapter of my thesis I provide a unified framework for analysing the complex interplay between diverse forms of globalisation, labour market frictions and wage inequality. In doing so I build a theoretical model that is able to explain my empirical findings from this first chapter of my thesis. The theory explains positive exporter and multinational premia for employment and wages and predicts imperfect correlations between firm employment, wages and international activity.

Bibliography

- Abowd, J. M., F. Kramarz, and D. N. Margolis (1999). High wage workers and high wage firms. *Econometrica* 67(2), 251–333.
- Alda, H., S. Bender, H. Gartner, et al. (2005). European data watch: the linked employer-employee dataset created from the iab establishment panel and the process-produced data of the iab (liab). *Schmollers Jahrbuch: Journal of Applied Social Science Studies/Zeitschrift für Wirtschafts-und Sozialwissenschaften* 125(2), 327–336.
- Antràs, P. and S. R. Yeaple (2014). Multinational firms and the structure of international trade. *Handbook of International Economics* 4.
- Autor, D. H., L. F. Katz, and M. S. Kearney (2008). Trends in us wage inequality: Revising the revisionists. *The Review of economics and statistics* 90(2), 300–323.
- Bagger, J. and R. Lentz (2014). An empirical model of wage dispersion with sorting. *The Review of Economic Studies*.
- Baumgarten, D. (2013). Exporters and the rise in wage inequality: Evidence from german linked employer–employee data. *Journal of International Economics* 90(1), 201–217.
- Bernard, A. B., J. B. Jensen, and R. Z. Lawrence (1995). Exporters, jobs, and wages in us manufacturing: 1976-1987. *Brookings Papers on Economic Activity. Microeconomics*, 67–119.

- Bombardini, M., G. Orefice, and M. D. Tito (2015). Does exporting improve matching? evidence from french employer-employee data. Technical report, National Bureau of Economic Research.
- Brown, C. and J. Medoff (1989). The employer size-wage effect. *Journal of political Economy* 97(5), 1027–1059.
- Card, D., A. R. Cardoso, J. Heining, and P. Kline (2018). Firms and labor market inequality: Evidence and some theory. *Journal of Labor Economics* 36(S1), S13–S70.
- Card, D., J. Heining, and P. Kline (2013). Workplace heterogeneity and the rise of west german wage inequality. *The Quarterly journal of economics* 128(3), 967–1015.
- Chade, H., J. Eeckhout, and L. Smith (2017). Sorting through search and matching models in economics. *Journal of Economic Literature* 55(2), 493–544.
- Davidson, C., F. Heyman, S. Matusz, F. Sjöholm, and S. C. Zhu (2012). Liberalized trade and worker-firm matching. *American Economic Review* 102(3), 429–34.
- Dustmann, C., J. Ludsteck, and U. Schönberg (2009). Revisiting the german wage structure. *The Quarterly Journal of Economics* 124(2), 843–881.
- Eeckhout, J. and P. Kircher (2011). Identifying sorting—in theory. *The Review of Economic Studies* 78(3), 872–906.
- Eeckhout, J. and P. Kircher (2018). Assortative matching with large firms. *Econometrica* 86(1), 85–132.
- Egger, H. and U. Kreickemeier (2013). Why foreign ownership may be good for you. *International Economic Review* 54(2), 693–716.

- Felbermayr, G., A. Hauptmann, and H.-J. Schmerer (2014). International trade and collective bargaining outcomes: Evidence from german employer–employee data. *The Scandinavian Journal of Economics* 116(3), 820–837.
- Fischer, G., F. Janik, D. Müller, and A. Schmucker (2009). The iab establishment panel—things users should know. *Schmollers Jahrbuch* 129(1), 133–148.
- Fosfuri, A., M. Motta, and T. Rønde (2001). Foreign direct investment and spillovers through workers’ mobility. *Journal of international economics* 53(1), 205–222.
- Glass, A. J. and K. Saggi (2002). Multinational firms and technology transfer. *Scandinavian Journal of Economics* 104(4), 495–513.
- Görg, H., E. Strobl, and F. Walsh (2007). Why do foreign-owned firms pay more? the role of on-the-job training. *Review of World Economics* 143(3), 464–482.
- Grossman, G. M., E. Helpman, and P. Kircher (2017). Matching, sorting, and the distributional effects of international trade. *Journal of political economy* 125(1), 224–264.
- Gumpert, A. (2015). The organization of knowledge in multinational firms. *Journal of the European Economic Association*.
- Helpman, E., O. Itskhoki, M.-A. Muendler, and S. J. Redding (2017). Trade and inequality: From theory to estimation. *The Review of Economic Studies* 84(1), 357–405.
- Heyman, F., F. Sjöholm, and P. G. Tingvall (2007). Is there really a foreign ownership wage premium? evidence from matched employer–employee data. *Journal of International Economics* 73(2), 355–376.
- Klein, M. W., C. Moser, and D. M. Urban (2013). Exporting, skills and wage inequality. *Labour Economics* 25, 76–85.

- Lipsey, R. E. (2004). Home-and host-country effects of foreign direct investment. In *Challenges to globalization: Analyzing the economics*, pp. 333–382. University of Chicago Press.
- Lopes de Melo, R. (2018). Firm wage differentials and labor market sorting: Reconciling theory and evidence. *Journal of Political Economy* 126(1), 313–346.
- Martins, P. S. (2011). Paying more to hire the best? foreign firms, wages, and worker mobility. *Economic Inquiry* 49(2), 349–363.
- Munch, J. R. and J. R. Skaksen (2008). Human capital and wages in exporting firms. *Journal of International Economics* 75(2), 363–372.
- Navaretti, G. B., A. Venables, and F. Barry (2004). *Multinational firms in the world economy*. Princeton University Press.
- OECD (2018). Fdi stocks (indicator).doi: 10.1787/80eca1f9-en (accessed on 05 september 2018).
- Oi, W. Y. and T. L. Idson (1999). Firm size and wages. *Handbook of labor economics* 3, 2165–2214.
- Rogerson, R., R. Shimer, and R. Wright (2005). Search-theoretic models of the labor market: A survey. *Journal of economic literature* 43(4), 959–988.
- Sampson, T. (2014). Selection into trade and wage inequality. *American Economic Journal: Microeconomics* 6(3), 157–202.
- Schank, T., C. Schnabel, and J. Wagner (2007). Do exporters really pay higher wages? first evidence from german linked employer–employee data. *Journal of international Economics* 72(1), 52–74.
- Shatz, H. J. and A. Venables (2000). *The geography of international investment*, Volume 2338. World Bank Publications.

- Shimer, R. and L. Smith (2000). Assortative matching and search. *Econometrica* 68(2), 343–369.
- Song, J., D. J. Price, F. Guvenen, N. Bloom, and T. Von Wachter (2015). Firming up inequality. Technical report, National Bureau of Economic Research.
- Tanaka, A. (2015). Wage premiums for exporters and multinational enterprises: Evidence from japanese linked employer-employee data. Technical report, Research Institute of Economy, Trade and Industry (RIETI).
- Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the mexican manufacturing sector. *The Quarterly Journal of Economics* 123(2), 489–530.

Chapter 2

Heterogeneous Globalisation, Labour Market Rigidities and Wage Inequality

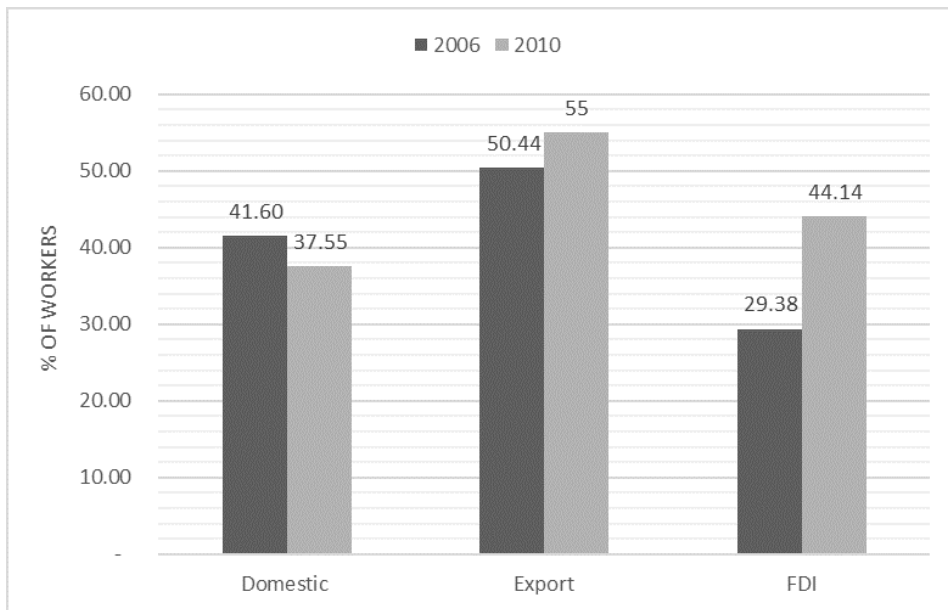
2.1 Introduction

The structure of global interdependence has changed from a trade-oriented to a production-oriented system, where multinational firms are regarded as the locus of transnational economic activities.¹ Differences in firms' mode of foreign market entry, in turn, may have diverse implications for wage inequality within and across countries.

Figure 1 presents the share of workers in firms with different modes of foreign market entry in Germany between 2006 and 2010. The Figure highlights that a growing share of the labour force is employed by firms that are active in international markets either via exporting or FDI activity. During the same period, Germany's labour market was subjected to a major labour market reform with the aim to increasing the effectiveness and efficiency of the labour market.²

¹Shatz and Venables (2000), Navaretti et al. (2004) and Antràs and Yeaple (2014) provide some stylized facts concerning recent developments regarding exporting and multinational activity.

²The reform is also known as 'Hartz 4', which was implemented in 2003-2005. The set of reforms



Notes: The figure shows the share of workers in domestic, exporting and FDI establishments in Germany. Firms are classified as: (1) Domestic, i.e. firms with no international activity, (2) exporters, which are firms that report positive exporting, and (3) 'FDI', are firms that report inward/outward FDI. The analysis is based on German linked employer-employee (LIAB) data for the year 2006 and 2010. The sample corresponds to all private sector firms with at least 5 employees and workers between 16 and 65 years for which data is available on a set of individual characteristics.

Figure 2.1: Share of Workers in Exporting and FDI Firms in Germany (2006-2010)

These developments motivate the following questions I address in this paper: First, to what extent and through which mechanism do different modes of foreign market entry affect labour market outcomes within a country? Second, how do institutional changes, such as labour market reforms, condition the relationship between these aspects of globalisation and labour market outcomes.

To answer these questions, I build a two-country, two-sector general equilibrium model that links these two distinct forms of globalisation, namely trade and FDI, to differences in wages, employment and workforce composition across firms. The

implemented may loosely be grouped into those reducing reservation wages, those increasing the efficiency of the job search process, and those allowing employers more flexibility. For a discussion on the labour market implications of these reforms see for example Ochel (2005), Jacobi and Kluve (2006) and Fahr and Sunde (2009).

mechanism is based on a model with *ex-ante* homogeneous workers, heterogeneous firms and search and matching frictions as in Helpman et al. (2017), within a trade model with monopolistic competition à la Melitz et al. (2004). By including foreign direct investment by multinational firms, this paper provides novel insights into the interaction between firm specific factors and firms' international activities in determining wage inequality and in particular, the multinational wage premium.

The model features three sources of firm heterogeneity. Besides the by now standard productivity heterogeneity à la Melitz (2003), the model additionally incorporates firm heterogeneity with respect to the size of fixed costs of market entry, and heterogeneity in the cost of screening workers. While the first source of heterogeneity may be attributed to a firm's ability to *use* the given resources of the firm, the efficiency in screening relates to a firm's ability to *find* the right labour inputs.³ Moreover, heterogeneous screening costs allow for variation in wages across firms after controlling for their employment size and international activity, while idiosyncratic market entry costs allow some small low-wage firms to profitably engage in international activities and some large high-wage firms to serve only the domestic market.

Firms and workers meet in a labour market characterized by Diamond-Mortensen-Pissarides-type search and matching frictions. These search frictions give rise to multilateral bargaining between a firm and its workers. Workers are heterogeneous *ex-post*, however, *ex-ante* a worker's ability is not directly observable by his employer. Firms have access to a costly screening technology which allows them to identify workers with ability below a certain ability threshold, but it cannot identify the precise ability of each worker. Due to complementarities between the firm productivity and the average ability of its workers, firms have an incentive to screen workers to exclude those which fall below the chosen ability-threshold and in so doing, improve the average ability of their workforce. Hence, the model features

³Alternatively, the cost of screening can be interpreted as the unobserved part of a firm's productivity, as this kind of information is usually unavailable to the econometrician.

imperfect assortative matching on unobservables in the labour market.

The choice of serving the foreign market is modeled as in Melitz et al. (2004), where firms can choose between two ways of foreign market access. They can either export domestically-produced goods or they can supply the destination market by setting up a foreign affiliate (FDI). In both cases firms need to pay fixed costs to enter the foreign market. While exporting entails additional variable trade costs, FDI saves transport costs, but duplicates production facilities and therefore, requires higher fixed costs. When engaging in FDI activity, a multinational firm can transfer its screening technology to their foreign affiliate at no extra cost, but it needs to hire workers from the labour market in the foreign country, subject to the labour market rigidities of this country.⁴

The first main result relates to the selection of firms into different modes of foreign market entry. Firm characteristics are systematically related to international activity, where firms with superior average characteristics - in terms of productivity, screening efficiency or fixed export/FDI cost - become exporters and firms with an even higher firm specific triplet, serve foreign markets via FDI. Furthermore, I show that the trade-off between exporting and FDI activity is determined by the difference between fixed costs of FDI and exporting, the size of variable trade costs, and the relative labour market friction of the two countries. Intuitively, the more flexible the foreign labour market and the larger the fixed and variable trade costs of exporting are, the more attractive firms will find it to serve the foreign market via FDI.

Second, firms with higher average characteristics are larger, more selective in the labour market and since higher-ability workforces are more costly to replace in the bargaining game, they also pay higher wages. Through this mechanism, internationalising firms are larger, have workforces of higher average ability and pay higher wages than non-internationalising firms. Therefore, this framework features

⁴Bloom et al. (2012) provide evidence that US multinationals transplant their business models to their overseas affiliates and that tougher “people management” practices are related to US firms’ productivity advantages. They show that this holds for both domestically based US firms as well as US multinationals operating in Europe.

residual wage inequality in the sense that *ex ante* identical workers receive different wages depending on whether they are matched with an exporter, a multinational firm or non-internationalising firms. Moreover, the mode of foreign market entry exhibits a clear hierarchy, where FDI firms can be ranked higher with regard to size, average workforce ability and wage premia.

Third, a distinctive feature of my framework is the presence of inward FDI (from the perspective of the home country), which introduces a new channel through which globalisation can affect labour market outcomes. A key assumption is that hiring and wage bargaining take place on the plant level, which implies that employment size and wages may differ within the same multinational firm, across its two affiliated plants. Furthermore, the ability of multinationals to transfer their screening technology to their foreign affiliates, gives rise to differences in the size, screening intensity and hence, workforce composition and wages between domestically owned multinationals (outward FDI) and foreign owned multinationals (inward FDI).⁵ Importantly, this is true for multinational firms with identical firm characteristics, but that only differ with respect to their country of origin. Whether inward or outward FDI firms pay more is driven by differences in labour market frictions across countries.

Related Literature. This paper contributes to the growing literature on the effects of globalisation on labour market outcomes in the presence of labor market frictions.⁶ My framework shares some basic features of heterogeneous firm models that link firms' employment and wage outcomes to trade participation through a Melitz (2003) mechanism (e.g. Egger and Kreickemeier (2009), Helpman et al. (2010), Felbermayr et al. (2011) and Coşar et al. (2016)).⁷ In particular my model can be viewed as an extension of Helpman et al. (2017). Motivated by stylised facts, they build a

⁵Fabbri et al. (2003) suggest that multinationals can more easily substitute away from labor in any one country, which may be an additional channel for differences in employment size and wages.

⁶My paper is also related to research that emphasizes a country's flexibility in the labour market as a source of comparative advantage. See for example Helpman and Itskhoki (2010) and Cuñat and Melitz (2012).

⁷Many other recent papers examine the effects of trade on labour market outcomes, such as Davidson et al. (1999), Davidson et al. (2008) Amiti and Davis (2011), Dix-Carneiro (2014), and Grossman et al. (2017)

theoretical model that focuses on wage inequality between firms for workers with similar observed characteristics. They extend Helpman et al. (2010) which features heterogeneity in firm productivity, to also incorporate heterogeneity in the cost of screening workers and the size of fixed exporting costs. In doing so their theory explains positive exporter premia for employment and wages and predicts imperfect correlations between firm employment, wages and export status. Their findings are in line with other empirical studies that establish the existence of the exporter wage premium, such as Bernard et al. (1995) Schank et al. (2007), Verhoogen (2008), and Baumgarten (2013).

My main point of departure from Helpman et al. (2017) is the introduction of multinational activity. This part of my theory is based on the framework by Melitz et al. (2004).⁸ They build upon the Melitz (2003) trade model to explain the decisions of heterogeneous firms to serve foreign markets through exports or local subsidiary sales. These modes of market access have different relative costs, some of which are sunk (such as entry costs) while others vary with sales (such as transport costs and tariffs). Relative to FDI, exporting involves lower sunk costs but higher per-unit cost. The idea is that, firms engage in FDI activity when the gains from avoiding transport costs outweigh the costs of maintaining capacity in multiple markets.⁹ Their model predicts that the least productive firms serve only the domestic market, that relatively more productive firms export, and that the most productive firms engage in FDI. They provide empirical evidence supporting this sorting pattern, which are in line with findings by others studies, such as Head and Ries (2003) and Tomiura (2007).

Finally, as my paper provides a theoretical explanation for the multinational wage premium, it contributes to the growing literature examining the implications of

⁸Other theories of exporting and FDI are for example Horstmann and Markusen (1992), Brainard (1993) and Markusen and Venables (2000).

⁹This is more generally known as the proximity-concentration trade-off. Brainard (1993) shows how trade costs, market size, and plant-level economies of scale interact to explain the export and FDI decision of firms producing differentiated products.

multinational activity for labour market outcomes. Theoretical contributions include Fosfuri et al. (2001), Glass and Saggi (2002), Egger and Kreickemeier (2013) and Gumpert (2015) and Heyman et al. (2007), Görg et al. (2007) and Martins (2011) provide empirical evidence for the multinational wage premium.

The remainder of the paper is structured as follows. Section 2 outlines the model and solves for general equilibrium. Section 3, provides a discussion of the model implications and section 4 concludes.

2.2 The Model

I build a two-sector, two-country model, where firms in the differentiated product sector can choose between exporting and (horizontal) FDI to enter foreign markets. International activity is based on a proximity-concentration tradeoff as in Melitz et al. (2004). Furthermore, heterogeneous firms meet with *ex-ante* identical workers in a labour market characterized by matching frictions similar to Helpman et al. (2010) and Helpman et al. (2017). The main prediction of the model relates to the distribution of wages and employment across firms that engage in international activity through diverse modes of foreign market entry in the presence of frictions in the labour market.

2.2.1 Model Setup

Household problem

There are two countries, home and foreign, where foreign variables are denoted by an asterisk. A country is endowed with a unit measure of identical households of size L . Each member of the household has one indivisible unit of labour which is supplied inelastically with zero disutility. Consumers are risk neutral and have preferences represented by a utility function which is defined over a Cobb-Douglas aggregate (C) of a homogeneous good (q_0) and a real consumption index of differentiated varieties

$(Q)^{10}$:

$$C = q_0^\alpha Q^{1-\alpha}, \quad 0 < \alpha < 1 \quad (2.1)$$

where α is a share parameter.

The household's budget constraint is given by

$$q_o + \int_{j \in J} p(j)q(j)dj \leq Y, \quad (2.2)$$

where I have chosen the homogeneous good as the numeraire and j indexes varieties and J is the set of varieties within the differentiated sector; $q(j)$ denotes consumption of variety j and $p(j)$ is its price. Y denotes the household's aggregate income.

Consumption of the differentiated product (Q), is given by a CES aggregator of individual varieties:

$$Q = \left[\int_{j \in J} q(j)^\beta dj \right]^{1/\beta}, \quad 0 < \beta < 1 \quad (2.3)$$

where the elasticity of substitution between varieties is given by β .¹¹

The Household maximises its expected utility by choosing how much to consume of each good and where to send its labour to work. More precisely, it allocates its L workers between the two sectors, where L is the sum of workers searching in the homogeneous (l_0) and differentiated sector (l). The homogeneous product sector has no labour market frictions and workers searching for jobs in this sector are expected to be employed with certainty and receive the wage w_0 . The differentiated sector is characterised by search frictions, where workers searching in this sector meet firms with some positive probability. Unmatched workers become unemployed. Conditional on being matched, workers learn the match-specific productivity, after which, they may be hired and receive a wage, or enter into unemployment. The value of

¹⁰For simplicity I consider a single differentiated sector. The analysis can be generalised to the case of multiple differentiated sectors.

¹¹While I here only display expressions for the home country, analogous relationships hold for foreign variables.

being unemployed is assumed to be equal to zero.

Firm problem

In the homogeneous sector firms are perfectly competitive, and one unit of labor is required to produce one unit of output. There are no trade costs. I focus on equilibria with incomplete specialisation, in which every country produces both homogeneous and differentiated goods. Under this assumption, normalising the price in the homogeneous sector to one, implies that the wage payed by a homogeneous good producers is also equal to one ($w_0 = 1$) in both countries. Below the conditions for incomplete specialisation shall be further defined.

The differentiated sector consists of a large number of monopolistically competitive firms, each supplying a distinct horizontally-differentiated variety. A firm revenue in this sector depends on the prices $p(j)$ of an individual variety j and a firm's output $y(j)$:

$$r(j) = p(j)y(j) \tag{2.4}$$

A firm can choose to enter the differentiated sector by paying an entry cost of $f_e > 0$. The firm then has to decide whether to exit, produce solely for the domestic market or to produce for both the domestic and foreign market. Production in the domestic market involves a fixed cost of $ef_d > 0$ units of the numeraire. The fixed cost is common to all firms and e is firm specific, independently distributed and drawn from a distribution G_e . The choice of serving the foreign market is modeled as in Melitz et al. (2004), where firms can choose between two ways of foreign market access: They can either export domestically-produced goods or they can supply the destination market by setting up a foreign affiliate (FDI).¹² In both cases a firm has to incur fixed costs when entering the foreign market, i.e. $ef_x > 0$ for exporting and

¹²I here assume that diseconomies of scope prevent firms from serving the foreign market through both, exporting and FDI activity.

$ef_i > 0$ for FDI activity, respectively. Furthermore, exporting is subject to iceberg variable trade cost, such that $\tau > 1$ units of a variety must be exported in order for one unit to arrive in the foreign market. Relative to exports, FDI saves transport costs, but duplicates production facilities and therefore requires higher fixed costs, which requires $f_i > f_x$.

Output of each variety (y) depends on the productivity of the firm (z), the measure of workers hired (h), and the average ability of these workers (\bar{a}):

$$y = zh^\gamma \bar{a}, \quad 0 < \gamma < 1 \quad (2.5)$$

where the productivity of the firm z is independently distributed and drawn from a distribution $G_z(z)$.¹³ The firm technology in (4) has the following important features.¹⁴ First, $\gamma < 1$ implies that there are decreasing returns to hiring more workers as, for example captured in the span of control model by Lucas (1978). Second, the productivity of a worker depends on the average ability of the entire workforce in the firm. Third, there is a complementarity between a firm's productivity and workers' ability. As will be shown below, these assumptions imply that firms face a trade-off between the quality and quantity of hired workers and worker ability matters relatively more for more productive firms.

The labour market is characterized by search frictions, where a firm has to pay bn units of the numeraire in order to be matched randomly with a measure n of workers.¹⁵

Workers differ in their ability, which is drawn from a Pareto distribution with support on $[1, \infty)$ and shape parameter $k > 1$: $G(a) = 1 - a^{-k}$ for $a \succeq 1$. Worker

¹³Since in equilibrium all firms with the same productivity behave symmetrically, firms are indexed by z .

¹⁴Helpman et al. (2010) show that this production function can be derived from human capital complementarities (e.g., production takes place in teams and the productivity of a worker depends on the average productivity of her team), or from a model of a managerial time constraint (e.g. a manager with a fixed amount of time who needs to allocate some time to every worker).

¹⁵For simplicity I assume that the hiring cost b is exogenous. Making b a function of labor market conditions, as in Helpman et al. (2010), does not affect the main results.

ability is assumed to be match-specific, and it is unknown both to the firm and to the worker. However, once the match is formed, the firm has access to a costly screening technology which allows it to identify workers with ability below a certain ability threshold a_c , but it cannot identify the precise ability of each worker. Screening costs increase with the ability threshold and equal $ca_c^\delta/d\delta$, where $c > 0$ and $\delta > 0$ are common to all firms and d is firm specific, independently distributed and drawn from a distribution $G_d(d)$. The intuition of this screening technology is that more complex and costlier tests are required for higher ability cutoffs.

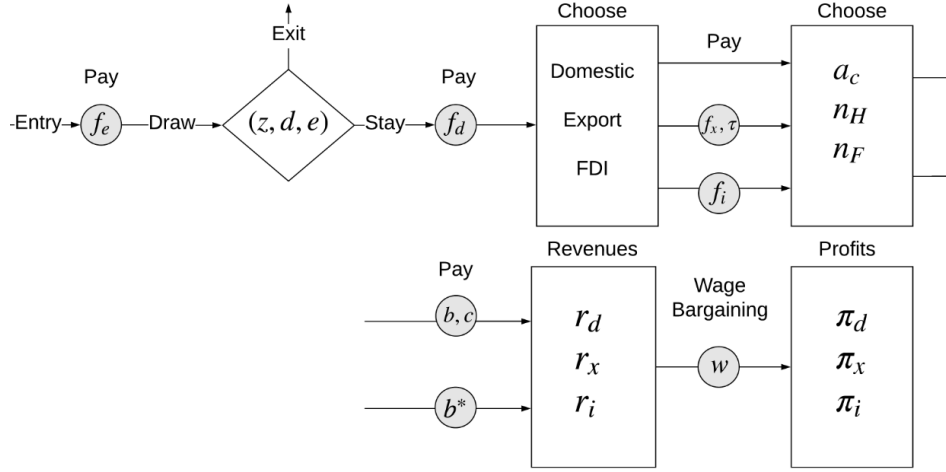


Figure 2.2: Timing of Decisions

The timing of decisions is as follows. Firms choose to enter and pay the free entry cost (f_e). Each firm learns its idiosyncratic draw (z, d, e) , corresponding to productivity, screening costs, and fixed costs of market entry, respectively. Given this triplet, the firm chooses whether or not to produce, whether to serve only the domestic market or to also serve the foreign market, either via exporting or by setting up a production plant abroad. Each firm then pays the search costs and matches with its chosen number of workers. After matching, the firm chooses its screening threshold and employs the workers with abilities above this threshold. Firms with FDI activity are able to transfer their screening technology to their foreign affiliate. Once these decisions have been made, the firm and its hired employees engage in bilateral Nash

bargaining with equal weights over the division of revenue from production in the manner proposed by Stole and Zwiebel (1996).¹⁶ The outcome of the bargaining game implies that the the firm receives the fraction $1/(1 + \beta\gamma)$ of revenues, while each worker receives the fraction $\beta\gamma/(1 + \beta\gamma)$ of average revenue per worker.

A firm that has searched for n workers and has chosen the ability cutoff a_c hires $h = n[1 - G(a_c)] = n(1/a_c)^k$ workers whose expected ability is $\bar{a} = \mathbb{E}\{a|a \geq a_c\} = a_c k/(k - 1)$. The production technology can thus, be rewritten as

$$y(z) = \frac{k}{k - 1} z n^\gamma (a_c)^{1 - \gamma k} \quad (2.6)$$

where output of a firm is increasing in the ability cutoff a_c . I further make an assumption on the following parameters which is maintained throughout.

Technical Assumption 1: $\gamma < 1/k$

This assumption implies that there are sufficiently strong diminishing returns relative to the dispersion of ability such that a firm can increase its output by not hiring the least productive workers. Therefore, firms have an incentive to screen workers to identify low-ability matches.¹⁷

Equilibrium

In equilibrium the household takes prices and wages as given and maximises its utility subject to the budget constraint. It allocates its labour endowment between the two sectors to generate income and then uses its labour income to purchase its utility maximising bundle of goods.

Firms maximise profits subject to fixed costs of market entry, search and screening

¹⁶See Appendix A for a detailed description of the the wage bargaining outcome.

¹⁷If $\gamma > 1/k$ no firm wants to screen because employing even the least productive worker raises the firm's output and revenue, while screening is costly.

costs. The optimal choices of the firm crucially depend on the idiosyncratic draw z, d and e . As it is the triplet as a whole that matters, I will subsequently define Z as a function of the firm's idiosyncratic shocks to describe equilibrium outcomes.¹⁸

The equilibrium will then consist of Z -cutoffs in the home and foreign country for production, exporting and FDI activity, which in turn yields five conditions that characterise the equilibrium in the home country: a distribution of prices, wages, employment and ability thresholds in the differentiated sector $(p(Z), w(Z), y(Z), h(Z), a_c(Z))$ and an analogous equilibrium vector for the foreign country $((p^*(Z), w^*(Z), y^*(Z), h^*(Z), a_c^*(Z)))$. The set of prices and quantities are such that all markets clear: supply matches demand on the labour and on the goods market.

2.2.2 Model Solution

Household choices

Expenditure

The consumer's maximisation problem implies that consumers spend α on the homogeneous good and $1 - \alpha$ on the differentiated good. Thus, aggregate expenditure in the differentiated sector is given by $E = PQ$ and in terms of expenditure shares can be expressed as

$$PQ = (1 - \alpha)Y, \quad (2.7)$$

where P is the price index in the differentiated sector and is the dual of the demand function of the differentiated good in (3), given by:

$$P = \left[\int_{j \in J} p(j)^{\frac{-\beta}{1-\beta}} dj \right]^{-\frac{1-\beta}{\beta}} \quad (2.8)$$

where the price of a variety is given by

$$p(j) = PQ^{1-\beta} y(j)^{-(1-\beta)} \quad (2.9)$$

¹⁸See equation (20) for the exact functional form of $Z(z, d, e)$.

Income

The market clearing condition for the labour market is given by the following equation:

$$L = l_0 + l, \quad (2.10)$$

which implies that aggregate labour supply is equal to the sum of workers searching in the homogeneous (l_0) and differentiated sector (l). In equilibrium workers are indifferent between searching in the two sector. This requires that the expected wage rate in the differentiated sector equals the wage in the homogeneous sector. As expected income equals one in each sector, each country's aggregate labour income is determined by its labour endowment:

$$Y = L, \quad (2.11)$$

and direct utility is given by

$$V = \frac{L}{P^{1-\alpha}}. \quad (2.12)$$

In the main analysis I assume that parameters are such that both countries produce the homogeneous good. As discussed in Helpman et al. (2010)) incomplete specialization can be ensured by appropriate choice of labour endowments (L, L^*) and relative preferences for the homogeneous and differentiated goods (α).

Firm choices

Revenues

Given the solution of the household problem, a firm's revenue can be expressed in terms of its output supplied $y(Z)$ and a demand shifter A for the sector:

$$r(Z) = Ay(Z)^\beta, \quad A \equiv PQ^{1-\beta} \quad (2.13)$$

The demand shifter A is a measure of product market competition, increasing in the sectoral expenditure and decreasing in the sectoral price index P . Since every firm is small relative to the sector, firms take this demand shifter as given.

Given consumer love of variety and fixed production costs, no firm will ever serve the export or FDI market without also serving the domestic market. Total output of a firm is the sum of production for the domestic and the foreign market, which the firm serves either via exporting or through multinational production. In order to distinguish between plants in the home country and abroad, I introduce the subscripts H and F , where H refers to production in the home country and F relates to production in the foreign country. Hence, production by a home firm for the home market is denoted as $y_H(Z)$ and $y_F(z)$ is the amount produced by a home firm in the foreign market through FDI activity.¹⁹

Total revenues can then be rewritten as the sum of revenues from the home plant $r_H(Z)$ and the foreign plant $r_F(Z)$:

$$r(Z) = \Upsilon_H(Z)^{1-\beta} A y_H(Z)^\beta + I_i(Z) A^* y_F(Z)^\beta \quad (2.14)$$

where $I_x \in 0, 1$ is an indicator function for whether a firm exports and $I_i \in 0, 1$ for FDI activity respectively. Note that if a firm decides to serve the foreign market via exporting, i.e. $I_x = 1$, then the indicator function for FDI activity will be $I_i = 0$ and vice versa if the firm engages in FDI the indicator function I_i equals 1 and I_x is equal to zero. Moreover, $\Upsilon_H(Z)$ refers to the “market access” variable:

$$\Upsilon_H(Z) \equiv 1 + I_x(Z) \tau^{-\frac{\beta}{1-\beta}} \left(\frac{A^*}{A} \right)^{\frac{1}{1-\beta}}.$$

which depends on whether a home producer, in addition to selling in the home market, also serves the foreign market via exporting. The equation further highlights that exporting activity does not only depend on the relative demand shifters of the

¹⁹For simplicity, I exclude the possibility of exports by foreign affiliates. See Appendix of Melitz et al. (2004), for an extension.

foreign and home country, but also on the variable trade cost τ .²⁰

Search and Screening Choice

The solution to the firm's problem is solved in a recursive way: Anticipating this bargaining outcome, a firm maximizes its profits by choosing the number of workers to match with in the home plant (n_H) and in the FDI-plant (n_F), the screening threshold (a_c), and whether to export or to set up a foreign affiliate:

$$\begin{aligned} \pi(z) \equiv \max_{\substack{n_H \geq 0; \quad n_F \geq 0 \\ a_c \geq 1 \\ I_x \in \{0,1\}; \quad I_i \in \{0,1\} \\ \text{if } I_x=1, I_i=0}} \left\{ \frac{1}{1 + \beta\gamma} \left[\Upsilon_H^{1-\beta} A \left(\frac{k}{k-1} z n_H^\gamma a_c^{1-\gamma k} \right)^\beta + I_i A^* \left(\frac{k}{k-1} z n_F^\gamma a_c^{1-\gamma k} \right)^\beta \right] + \right. \\ \left. - b n_H - I_i b^* n_F - \frac{c}{d\delta} a_c^\delta - e f_d - I_x e f_x - I_i e f_i \right\} \end{aligned} \quad (2.15)$$

The firm's first order conditions for the measure of workers sampled for the home establishment (n_H) and for the foreign affiliate (n_F) are:

$$\frac{\beta\gamma}{1 + \beta\gamma} r_H(Z) = b n_H(Z) \quad (2.16)$$

$$\frac{\beta\gamma}{1 + \beta\gamma} r_F(Z) = b n_F(Z) \quad (2.17)$$

And first order condition with respect to the screening ability threshold (a_c) is given by

$$\frac{\beta(1 - \gamma k)}{1 + \beta\gamma} r(Z) = \frac{c}{d} a_c(Z)^\delta \quad (2.18)$$

Equations (16) and (17) can be combined to express the optimal sampling decision

²⁰The market access variable $\Upsilon_H(z)$ is derived by noting that a home producer with exporting activity, equate marginal revenues in the two markets, which from (1) implies

$$\frac{y_x}{y_d} = \tau^{-\frac{\beta}{1-\beta}} \left(\frac{A^*}{A} \right)^{\frac{1}{1-\beta}}$$

and output of a home plant can then be written as $y_H(Z) = y_d(Z) \Upsilon_H(z)$

in terms of total revenues ($r(Z)$):

$$\frac{\beta\gamma}{1+\beta\gamma}r(Z) = bn_H(Z) \frac{\Upsilon_H(Z)^{1-\beta} + I_i(Z) \left(\frac{b}{b^*}\right)^{\frac{\gamma\beta}{1-\gamma\beta}} \left(\frac{A^*}{A}\right)^{\frac{1}{1-\gamma\beta}}}{\Upsilon_H(Z)^{1-\beta}}, \quad (2.19)$$

As a result, a firm's optimal choice depends on the *relative* level of labour market frictions (b/b^*) and demand shifters (A^*/A), rather than the absolute values.²¹ Equations (18) and (19) imply that, ceteris paribus, firms with larger revenue interview more workers (higher n_H) and screen more intensively (higher a_c) and consequently, hire workers with higher average ability. I next make an assumption that ensures that firms that screen to a higher ability cutoff also hire more workers (higher h_H):

Technical Assumption 2: $\delta > k$

Using the firms' first-order conditions (18) and (19), firm revenue (14) and the production technology (6), we can solve explicitly for firm revenue as a function of the firm variable z , the demand shifter A , the search cost b , and parameters:

$$r(Z) = \kappa_r \left[c^{-\frac{\beta(1-\gamma-k)}{\delta}} b^{-\gamma\beta} A \Upsilon(Z) \right]^{\frac{1}{\Gamma}} z^{\frac{\beta}{\Gamma}} d^{\frac{\beta(1-\gamma k)}{\delta\Gamma}} \quad (2.20)$$

where $\kappa_r \equiv (k/k-1)^\Gamma (\beta\gamma/1+\beta\gamma)^{\beta\gamma/\Gamma} [\beta(1-\gamma k)/1+\beta\gamma]^{\beta(1-\gamma k)/\delta k}$ and $\Gamma \equiv 1 - \beta\gamma - \beta(1-\gamma k)/\delta$. Technical Assumption 1 and 2 together imply that $\Gamma > 0$, which ensures that revenues are increasing in firm characteristics.

Furthermore, $\Upsilon(Z)$ denotes a firm's aggregate market access variable, including

²¹See Appendix B for a detailed derivation of the first order conditions.

exporting and FDI activity and is hence, given by

$$\Upsilon(Z) \equiv \begin{cases} 1 & \text{if } I_x(Z) = I_i(Z) = 0 \\ \Upsilon_x & \text{if } I_x(Z) = 1 - I_i(Z) = 1, \\ \Upsilon_i & \text{if } I_i(Z) = 1 - I_x(Z) = 1, \end{cases} \quad \begin{aligned} \Upsilon_x &\equiv \left(1 + \tau^{-\frac{\beta}{1-\beta}} \left(\frac{A^*}{A}\right)^{\frac{1}{1-\beta}}\right)^{1-\beta} \\ \Upsilon_i &\equiv \left(1 + \left(\frac{A^*}{A}\right)^{\frac{1}{1-\gamma\beta}} \left(\frac{b}{b^*}\right)^{\frac{\gamma\beta}{1-\gamma\beta}}\right)^{1-\gamma\beta} \end{aligned} \quad (2.21)$$

which includes additional revenue premium of exporters (Υ_x) and of FDI activity (Υ_i), depending on which mode of foreign market access is chosen by the firm. Using the first order conditions and the expression of revenues in (20), firm profits can be rewritten as

$$\pi(Z) = \frac{\Gamma}{1 + \beta\gamma} r(Z) - ef_d - I_x(Z)ef_x - I_i(Z)ef_i \quad (2.22)$$

where I define the combination of firm-specific idiosyncratic draws as $Z \equiv zd^{(1-\gamma k)/\delta}/e^{\Gamma/\beta}$.

Firm Outcomes

Wages are determined by wage bargaining as described above, where bargaining takes place at the plant level. The wage paid to workers in establishments of home producers is given by

$$w_H(Z) = \frac{\beta\gamma}{1 + \beta\gamma} \frac{r_H(Z)}{n_H(Z)a_c(Z)^{-k}} = ba_c(Z)^k \quad (2.23)$$

and workers in in the foreign affiliate of the home firm receive

$$w_F(Z) = \frac{\beta\gamma}{1 + \beta\gamma} \frac{r_F(Z)}{n_F(Z)a_c(Z)^{-k}} = b^*a_c(Z)^k \quad (2.24)$$

These equations imply that the wage is equal to the replacement cost of a worker,

which is proportional to the search cost b and increasing in the screening cutoff a_c .²² From (18),(19) and (20) it follows that if the revenue premium from FDI activity (Υ_i) is larger than the one from exporting (Υ_x), firms with multinational activity are more selective in the labour market and hence, pay higher wages than exporting and local firms. I will further discuss the implications of FDI and exporting activity for wage inequality in section 3.

As stated above, if $\delta > k$, the ability threshold a_c is increasing with h and we can state that the model exhibits an employer-size wage premium, where firms that employ more workers (and screen more intensively), pay higher wages.²³

Next, we can find the analogous expressions for employment in home and foreign plants by noting that $h \equiv na_c^{-k}$. Employment can then be expressed as function of revenues of the plant which is hiring the workers, i.e. either by the home plant $r_H(Z)$ or by a home firm's foreign affiliate $r_F(Z)$, proportional to total revenues:

$$h_H(Z) = \kappa_h c^{\frac{k}{\delta}} b^{-1} r_H(Z) r(Z)^{-\frac{k}{\delta}} d^{-\frac{k}{\delta}} \quad (2.25)$$

$$h_F(Z) = \kappa_h c^{\frac{k}{\delta}} b^{*-1} r_F(Z) r(Z)^{-\frac{k}{\delta}} d^{-\frac{k}{\delta}} \quad (2.26)$$

where $\kappa_h \equiv (\beta\gamma/1 + \beta\gamma)(\beta(1 - \gamma k)/1 + \beta\gamma)^{-k/\delta}$. The implications for employment are as follows. Exporters and FDI firms both hire more workers than firms that are only active in the domestic market and for $\Upsilon_i > \Upsilon_x$, multinational firms tend to be largest in terms of their workforce. Furthermore, firms which generate more revenue in the home plant also hire more workers, holding revenue in the foreign affiliate constant. Vice versa holds for firms which generate more revenues in the foreign plant.

²²Note that conditional on being sampled, the expected wage is the same across firms: $w(Z)h(Z)/n(Z) = b$

²³This feature of the model is in line with empirical findings that the employer-size wage premium is partly explained by differences in the unobserved heterogeneity of workers across firms as shown by Abowd et al. (1999), Card et al. (2013) and Song et al. (2015).

Export and FDI Choice

As a result of fixed costs of production (f_d, f_x and f_i , respectively) and variable trade costs, a firm's decision whether or not to produce and to export or engage in FDI, imply that there is a zero-profit cutoff for the firm-specific triplet $Z(z, d, e)$, for which a firm will be willing to serve the domestic market, Z_d , choose to export, Z_x and if the observed productivity draw is high enough, Z_i , the firm will find it profitable to set up a foreign affiliate. This implies the following order of cutoffs: $Z_i \geq Z_x \geq Z_d$. Using the expression for profits in (22) we can find the zero profit-cutoffs.

The Z -cutoff below which firms exit is determined by the requirement that a firm with this combination of z, d, e , makes zero profits, i.e. $\pi(Z_d) = 0$. Hence, a firm will produce if

$$Z \geq Z_d \equiv A^{-\frac{1}{\beta}} c^{\frac{1-\gamma k}{\delta}} b^\gamma \left[\frac{f_d}{\kappa_r} \frac{1 + \beta\gamma}{\Gamma} \right]^{\frac{\Gamma}{\beta}} \quad (2.27)$$

The analogous export-cutoff can be found by noting that the firm's zero profit conditions require that firms are indifferent between serving only the domestic market and serving both the domestic and foreign market through exporting ($\pi(\Theta_x) - \pi(\Theta_d) = 0$). A firm's exporting decision is determined by the following two equations :

$$Z \geq Z_x \equiv \left[\Upsilon_x^{\frac{1}{\Gamma}} - 1 \right]^{-\frac{\Gamma}{\beta}} \left(\frac{f_x}{f_d} \right)^{\frac{\Gamma}{\beta}} Z_d \quad (2.28)$$

$$Z < Z_i \equiv \left[\Upsilon_i^{\frac{1}{\Gamma}} - \Upsilon_x^{\frac{1}{\Gamma}} \right]^{-\frac{\Gamma}{\beta}} \left(\frac{f_i - f_x}{f_d} \right)^{\frac{\Gamma}{\beta}} Z_d \quad (2.29)$$

where the FDI Z_i cutoff above which firms set up a foreign affiliate (Z_i) is determined by the requirement that a firm is indifferent between serving the foreign market via exporting and FDI ($\pi(Z_i) - \pi(Z_x) = 0$). Consequently, firms engage in FDI activity if

$$Z \geq Z_i. \quad (2.30)$$

Note that theoretically there are many possible cases for the order of cutoffs. For

example, it could be that only the most productive export and less productive firms do FDI, which implies $Z_x \geq Z_i \geq Z_d$.²⁴ However, here I am focusing on the case where all firms that export or do FDI, also serve the domestic market, and firms that produce for the domestic market may or may not participate in international activities. Moreover, I assume that only the most productive firms engage in FDI. This implies the following order of cutoffs $Z_i \geq Z_x \geq Z_d$, as described above. Under the assumption that $f_i > f_x$ it is sufficient to require that the revenue premium from FDI activity (Υ_i) to be larger than for exporting (Υ_x) in order to ensure that the cutoff of FDI to be greater than the exporting cutoff (see (28) and (29)). Hence, whether a firm will choose to engage in FDI activity, rather than exporting, will depend on the difference between the fixed costs of FDI (f_i) and exporting (f_x), and on the difference between the firm revenue premium of FDI activity (Υ_i) and exporting (Υ_x). The latter difference in turn, depends on the size of the variable trade costs τ ; the closer τ to 1, the larger Υ_x , which implies that firms find it relatively more profitable to export as iceberg trade costs vanish. Furthermore, equations (27) - (20) highlight that firm characteristics through $Z(z, d, e)$ are systematically related to export and FDI participation. Given this triplet, the distribution of exporters and firms engaging in FDI, depends not only on the distribution of productivities (z), but also on the the distribution of d and e between exporters and domestic firms, and between exporters and FDI-firms.

Moreover, these cutoffs depend on two dimensions of trade openness in (27), (28) and (39). First, they depend on an extensive margin of trade openness, as captured by the ratio of the firm-specific variable Z -cutoffs Z_d/Z_x , which determines the fraction of exporting firms. Similarly, Z_x/Z_i , which, in turn, determines the fraction of firms engaging in FDI activity. Second, the cutoffs depend on an intensive margin of trade openness, as captured by the two market access variables, $\Upsilon_x > 1$ and the revenue mark-up of FDI activity, which determine the ratio of revenues from domes-

²⁴We can also think of cases where everyone who produces also does FDI and there is no exporting, i.e. $Z_d \geq Z_i \geq Z_x$. However, this case seems empirically less relevant.

tic sales and exporting or FDI.

Entry

In equilibrium, we also require the free entry condition to hold, which equates the expected value of entry to the sunk entry cost:

$$f_d \int_{Z_d}^{\infty} \left[\left(\frac{Z}{Z_d} \right)^{\frac{\beta}{1-\alpha}} - 1 \right] dG_Z + f_x \int_{Z_x}^{Z_i} \left[\left(\frac{Z}{Z_x} \right)^{\frac{\beta}{1-\alpha}} - 1 \right] dG_Z + f_i \int_{Z_i}^{\infty} \left[\left(\frac{Z}{Z_i} \right)^{\frac{\beta}{1-\alpha}} - 1 \right] dG_Z = f_e \quad (2.31)$$

where $I_x(Z) = 1$ only if $Z_x \leq Z < Z_i$ and $I_x(Z) = 0$ otherwise. Similarly, $I_i(Z) = 1$ for $Z \geq Z_i$ and is zero otherwise. Evaluating the integrals in (31) using a Pareto distribution, together with the cutoff condition in (27), we can express the free entry condition as a function of the exit cutoff Z_d .

Market clearing

Next, the mass of firms within the sector (M) can be determined from the market clearing condition that total domestic expenditure on differentiated varieties equals the sum of the revenues of domestic and foreign firms that supply varieties to the domestic market:

$$(1 - \alpha)L = M \int_{Z_d}^{\infty} r_d(Z) dG_Z(Z) + M^* \int_{Z_x^*}^{Z_i^*} r_x^*(Z) dG_Z(Z) + M^* \int_{Z_i^*}^{\infty} r_i^*(Z) dG_Z(Z) \quad (2.32)$$

Labour

The equilibrium will then consist of Z -cutoffs in the home and foreign country for production, exporting and FDI activity, which in turn yields five conditions that characterise the equilibrium in the home country: a distribution of prices, wages, employment and ability thresholds in the differentiated sector $(p(Z), w(Z), y(Z), h(Z), a_c(Z))$ and an analogous equilibrium vector for the foreign country $((p^*(Z), w^*(Z), y^*(Z),$

$h^*(Z), a_c^*(Z)$). The set of prices and quantities are such that all markets clear: supply matches demand on the labour and on the goods market. The sectoral labor force (l) can be determined from the outcome of the bargaining game, where the total sectoral wage bill equals a constant fraction of total revenue:

$$l = M \int_{Z_d}^{\infty} w(Z) h(Z) dG_Z(Z) = M \frac{\beta\gamma}{1 + \beta\gamma} \int_{Z_d}^{\infty} r(Z) dG_Z(Z) \quad (2.33)$$

Equilibrium

There are five equations that characterize the equilibrium in each country as a function of the three Z -cutoffs.

Equations (27), (28), (29) and (30) determine the cutoffs for the home country (Z_d, Z_x, Z_i) and three analogous expressions yield the cutoffs for the foreign country (Z_d^*, Z_x^*, Z_i^*).

Combining the fact that first, the demand shifter is a function of total expenditure $A = PQ^{1-\beta}$ and second, that Cobb-Douglas preferences imply that expenditure of a good is a constant share $(1 - \alpha)$ of income (Y), i.e. $PQ = (1 - \alpha)Y$:

$$A = [(1 - \alpha)L]^{1-\beta} P^\beta \quad (2.34)$$

where I used the fact that income is equal to labour endowments from (11). We can again make use of an equivalent expression for the demand shifter to obtain A^* .

The expression for the demand shifters, together with the cutoffs and the mass of firms in (29) in the home and foreign country yield 10 conditions in total: ($Z_d, Z_x, Z_i, Z_d^*, Z_x^*, Z_i^*, A, A^*, M, M^*$). Together, with the firm outcomes in (18) - (26) as functions of Z , fully describe the model equilibrium.

2.3 Model Implications

In this section, I will use this general equilibrium model of two countries to further discuss the implications of the model for wage inequality. Furthermore, I will conduct a comparative statics exercise to derive results on the impact of labour market frictions on firm's choice of foreign market entry, and the resulting implications for the fraction of exporting and FDI firms in the economy.

2.3.1 Exporter and MNE Wage Premia

Wage Premia

I will now consider the implications of exporting and FDI for wages and the resulting difference in pay between exporters and multinationals in the home country . I start by taking logs of the wage equation in (23), and (24), which establishes the following relationship between a firm's choice of international activity and wages

$$\ln w_H = \mu_H + \frac{k}{\delta\Gamma} \ln \Upsilon(Z) + \frac{k}{\delta\Gamma} \ln Z + \frac{k}{\delta} \ln d + \frac{\Gamma}{\beta} \ln e \quad (2.35)$$

$$\ln w_H^* = \mu_H^* + \frac{k}{\delta\Gamma} \ln \Upsilon^*(Z) + \frac{k}{\delta\Gamma} \ln Z^* + \frac{k}{\delta} \ln d^* + \frac{\Gamma}{\beta} \ln e^* \quad (2.36)$$

where μ_H includes parameters that are common to all home country producers in their home establishments and μ_H^* refers to affiliated plants where the source country is foreign. The remaining parameters, in turn, can be interpreted as coefficients of a wage regression with the firm type and the log of different firm characteristics ($Z(z, d, e)$). Furthermore, equation (36) captures wages of foreign owned in affiliates in the home country and hence, from the perspective of Home captures inward FDI.

The relationship between firms' international activities and firm characteristics can be described as follows. Similar to Helpman et al. (2017), heterogeneity in firm productivity (z) drives differences in firm revenue, employment size and international

activity. Heterogeneity in the screening efficiency (d) allow for differences in wages across firms after controlling for their employment size and mode of foreign market access, while idiosyncratic market entry costs (e) allow some small low-wage firms to engage in exporting and FDI activity and vice versa some large high-wage firms to serve only the home market. Consequently, incorporating these three idiosyncratic shocks allows the model to produce a positive but imperfect correlation between wages, international activity and employment, as observed in the data.

Export vs FDI

First, we will consider the case in which firms do not participate in FDI activity, i.e $I_i = 0$, but allow for exporting $I_x = 1$. The effect of exporting on wages, controlling for other firm characteristics, is then equal to $(k/\delta\Gamma)(1 - \beta) \ln \Upsilon_x$. Due to fixed costs of exporting, there is a discrete increase in wages for exporters, as exporting implies that $\Upsilon(Z)$ increases from 1 to $\Upsilon_x > 1$. Next, let us consider the case for FDI ($I_i = 1$). Similarly to exporting, as a result of fixed costs, revenues increase discretely at the cutoff (Z_i) for entering the FDI market. While exporting implies that $\Upsilon(Z)$ increases from 1 to $\Upsilon_x > 1$, FDI activity comes along with an increase of Υ_i . The multinational wage premium is hence given by $(k/\delta\Gamma)(1 - \gamma\beta) \ln \Upsilon_i$.

Whether the wage premium of exporters or multinationals is larger, depends on the 'coefficient' and on the size of the market access variables themselves. First, the coefficient for FDI is greater than the analogous exporter coefficient ($(1 - \gamma\beta) > (1 - \beta)$), suggesting that the multinational wage premium may be larger. Second, both market access variables depend on the relative labour market friction (b/b^*) and on the relative demand shifter (A^*/A). Additionally, Υ_x is a function of the iceberg transportation cost (τ). Empirically, trade costs vary a lot across countries and the magnitude of trade costs depends on the specific pair of countries trading with one another. As Υ_x is decreasing in τ , countries with high bilateral trade costs have

greater multinational wage premia relative to the exporter premium ($\Upsilon_i > \Upsilon_x$).²⁵ On the other hand, if barriers to trade are very low it may be that exporters pay more than FDI firms. Although trade costs have been decreasing in the past decades, recent empirical findings, such as Anderson and Van Wincoop (2004) and Hummels and Schaur (2012), suggest that trade costs tend to be large even between highly integrated economies. Large trade costs, in turn, imply small market access variables for exporters (Υ_x), and hence, supports the notion that multinational wage premia are larger.

As there is a common wage for all workers *within* the same firm, wage differences *between* firms are driven by differences in the bargaining outcomes of firms with their employees. Therefore, as in Helpman et al. (2017), this framework features residual wage inequality in the sense that *ex ante* identical workers receive different wages depending on whether they are matched with an exporter or non-exporter. This is consistent with recent empirical evidence (e.g. Schank et al. (2007) and Helpman et al. (2017)), exporters not only have higher revenue and employment than firms that only operate in the domestic market, but also pay higher wages, as implied by the market access variable $\Upsilon_x > 1$. Additionally, my analysis features a multinational wage premium as found by Heyman et al. (2007) and Martins (2011).

Outward vs Inward FDI

Equation (36) further highlights that foreign owned multinationals (inward FDI) may pay different wages to domestically owned multinationals (outward FDI). For example, if we consider two multinational firms with identical firm specific draws ($Z(z, d, e)$), but that only differ with respect to their country of origin we can express the difference in pay between these firms as follows

$$\ln w_H - \ln w_H^* = (\mu_H - \mu_H^*) + \frac{k}{\delta\Gamma} (\ln \Upsilon(Z) - \ln \Upsilon^*(Z)) \quad (2.37)$$

²⁵Note that $\Upsilon_i > \Upsilon_x$ is a necessary condition for FDI to exist in the model.

where the remaining variables and parameters on the right hand side of this equation depend on the relative demand shifter (A^*/A) and the relative labour market frictions (b/b^*). Whether inward or outward FDI firms pay more will, thus, depend on which country has higher (lower) labour market frictions. I will discuss the implications of labour market rigidities for wage inequality in the next subsection.

2.3.2 Comparative Statics

In the comparative static exercise conducted below, each country, home and foreign, has labour market frictions of the type described in the previous section, with the coefficients varying across countries (b, b^*). I will focus on a scenario where the home country liberalises its labour market (lower b), implying a decrease in the *relative* rigidities (b/b^*).

Furthermore, in the following I will focus on productivity heterogeneity (z) as the only source of firm heterogeneity, implying that $d = e = 1$. This allows me to impose a particular distribution for (z). More precisely, a firm's productivity z is assumed to be independently distributed and drawn from a Pareto distribution $G_z = 1 - z^{-\varphi}$, for $z > 0$ and $\varphi > 1$.

Entry

Given that we now only have one source of heterogeneity and applying the pareto distribution to equation (28) yields the following expression for the free entry condition

²⁵This assumption is standard in the literature on trade and firm heterogeneity and provides a reasonable approximation for the observed distribution of firm sizes (e.g. Axtell (2001)), and provides a reasonable approximation for the upper tail of the observed distribution of worker wages (e.g. Saez (2001)).

$$\begin{aligned} & \left(\frac{\beta}{\varphi\Gamma - \beta} \right) \left[f_d + f_i \left(\frac{z_i}{z_d} \right)^{-\varphi} + f_x \left(\frac{z_x}{z_d} \right)^{-\varphi} \right] + \\ & + f_x \left(\frac{z_x}{z_d} \right)^{-\varphi} \left[\left(\frac{z_i}{z_x} \right)^{-\varphi} - \left(\frac{\varphi\Gamma}{\varphi\Gamma - \beta} \right) \left(\frac{z_i}{z_x} \right)^{-\left(\varphi - \frac{\beta}{\Gamma}\right)} \right] = z_d^\varphi f_e \end{aligned} \quad (2.38)$$

where the ratios of the different cutoffs are given by (27)- (29), which depend on the fixed costs of market entry and the market access variables for exporting and FDI activity. I further make an assumption on the following parameters which is maintained throughout.

Technical Assumption 3: $\varphi > \max \{ \beta/\Gamma, 1 \}$

The market access variables, in turn, are a function of the relative labour market friction (b/b^*) and the demand shifter (A^*/A). Using equation (27) and the equivalent expression for the foreign country, the relative demand shifter is given by

$$\frac{A^*}{A} = \left(\frac{b^*}{b} \right)^{\beta\gamma} \left(\frac{z_d^*}{z_d} \right)^{-\beta}. \quad (2.39)$$

which is increasing in b^*/b and decreasing in z_d^*/z_d . The relative domestic cutoffs are given by (39) and the equivalent expression for the foreign country.

Having defined the relative demand shifter, we can substitute this expression into (21) to obtain the market access variable for exporters and FDI firms, which enables us to study the effect of home's labour market policy on firms' exporting and FDI decisions. In order to perform this comparative statics exercise, I will consider two thought experiments. First, I will focus on the firms' exporting decisions, without FDI. Second, I allow for FDI, but no exporting to analyse the effect on FDI activity. In doing so, we will be able to identify the implications of a more flexible labour market (in the home country) for exporting and FDI choices separately.

Effect on Exporting

Consider the case where exporting is the only mode of foreign market entry, i.e. $f_i \rightarrow \infty$. Plugging (39) into (21) we can find an expression of the market access variable for exporters as a function of the relative labour market friction and the relative domestic cutoff:

$$\Upsilon_x \equiv \left(1 + \tau^{-\frac{\beta}{1-\beta}} \left(\frac{b^*}{b} \right)^{\frac{\gamma\beta}{1-\beta}} \left(\frac{z_d^*}{z_d} \right)^{-\frac{\beta}{1-\beta}} \right)^{1-\beta} \quad (2.40)$$

This expression makes clear that the revenue premium for exporting is increasing in the relative labour market friction b^*/b , which makes exporting more attractive. From equation (28), a higher Υ_x implies a decrease in the relative cutoff z_x/z_d . In other words, a more flexible labour market in the home country decreases the export cutoff and increases the domestic cutoff. The opposite holds for the foreign country, i.e. a higher b^*/b increases its export cutoff and lowers its domestic cutoff. This result for the export cutoff is quite intuitive, as the labour cost advantage in the home country allows firms to export profitably even with lower productivities. The effect on the domestic cutoff (z_d) comes from the fact that lower labour market rigidities (b) increase expected profits from exporting at the entry stage, which have to be offset with lower expected profits from domestic sales in order for the free entry condition to be satisfied. In order to see this formally, we can find the domestic cutoff for the exporting-only case from (38), given by

$$z_d = \left(\frac{\beta}{\varphi\Gamma - \beta} \right)^{\frac{1}{\varphi}} \left[\frac{f_d}{f_e} + \frac{f_x}{f_e} \left(\frac{f_d}{f_x} \right)^{\frac{\varphi\Gamma}{\beta}} \left[\Upsilon_x^{\frac{1}{\Gamma}} - 1 \right]^{\frac{\varphi\Gamma}{\beta}} \right]^{\frac{1}{\varphi}} \quad (2.41)$$

where I plugged in z_x/z_d from equation (28). As discussed above concerning equation (41), a decrease in the home country's labour market rigidity increases Υ_x and hence, raises the domestic cutoff z_d . Note that this, in turn, generates a positive feedback

effect through a higher relative cutoff z_d^*/z_d , which tends to further increase Υ_x . By applying the implicit function theorem to (41), it can be shown that a lower labour market frictions in the home country implies a higher zero-profit cutoff z_d .

This finding has important implications. A labour market reform in the home country has a similar effect to asymmetric trade liberalisation. A more flexible labour market increases a country's competitiveness and implies a lower cutoff for exporting, which induces within-industry reallocation of resources between firms. The least productive firms exit with the increase in the domestic zero-profit cutoff z_d , firms below the new export cutoff contract and the most productive firms above z_x (-new) expand.

Effect on FDI

Now consider the case where variable trade costs are prohibitively high, such that firms only enter the foreign market via FDI activity, i.e. $\tau \rightarrow \infty$. The market access variable for exporters as a function of the relative labour market friction and the relative domestic cutoff can be found by plugging (39) into (21):

$$\Upsilon_i \equiv \left(1 + \left(\frac{z_d^*}{z_d} \right)^{-\frac{\beta}{1-\beta}} \right)^{1-\gamma\beta} \quad (2.42)$$

Note that the the relative labour market rigidity, which was previously present in (21), has now cancelled out. I will discuss the implications below.

Similar to the exporting-only case, we can find an expression for the domestic cutoff in the presence of FDI activity, which is given by

$$z_d = \left(\frac{\beta}{\varphi\Gamma - \beta} \right)^{\frac{1}{\varphi}} \left[\frac{f_d}{f_e} + \frac{f_i}{f_e} \left(\frac{f_d}{f_i} \right)^{\frac{\varphi\Gamma}{\beta}} \left[\Upsilon_i^{\frac{1}{\Gamma}} - 1 \right]^{\frac{\varphi\Gamma}{\beta}} \right]^{\frac{1}{\varphi}} \quad (2.43)$$

Equation (42), together with (43) clarify that in the case of FDI-only the market access variable for FDI activity Υ_i , as well as the relative cutoff z_d^*/z_d remain unaffected by a change in the relative labour market friction. Likewise, the relative FDI

cutoff z_i/z_d does not change, and hence, the number of FDI firms remains constant.

At first glance this result may be surprising, as b^*/b does show up in the expression for the market access variable in (21). The reason for the neutral effect of a change in the relative labour market flexibility on cutoffs and the revenue premium is as follows. The direct effect of a change in b^*/b tends to decrease Υ_i as a more flexible labour market makes FDI activity less attractive for home country firms. However, this effect is being offset by the indirect effect through the relative demand shifter (A^*/A) . From (39) it follows that the relative demand shifter is decreasing in b^*/b . Intuitively, this indirect effect captures the fact that a more flexible labour market acts like efficiency improvements in this country, which is in line with a fall in the price index P in (34).

Importantly, although an improvement of the home country's labour market institution is neutral with respect to cutoffs and the market access variable for FDI activity, there may be welfare gains or losses. From the perspective of the home country, a lower aggregate Price index increases the household's direct utility (see (12)). In contrast, welfare in the foreign country falls due to a higher price in the economy. Therefore, a labour market reform in a country can turn into a beggar-thy-neighbour policy.

Lastly, it should be noted that by allowing for exporting and FDI activity simultaneously, the predictions concerning FDI may change. Changes in the relative labour market frictions will then change the mix of exporting and FDI firms and thus, alter the structure international activity.

2.4 Conclusion

Globalisation, has various faces. While, some firms choose to serve foreign markets via exporting at arms length, other firms decide to 'go full in' by selling through

²⁵This is also true for the exporting-only case, which is in line with the implications of the trade model by Helpman and Itskhoki (2010)

foreign affiliates. The first chapter of my thesis provided empirical evidence for the hypothesis that differences in firms' mode of foreign market entry, have diverse implications for labour market outcomes. In this paper, I build a theoretical model to study the implications of these two distinct forms of globalisation on labour market outcomes.

The analysis suggests that firms with superior average characteristics - in terms of productivity, screening efficiency or fixed export or FDI cost - become exporters and firms with an even higher firm specific triplet, serve foreign markets via FDI. As in Helpman et al. (2017), the participation of some but not all firms in international activities provides a mechanism for heterogeneous forms of globalisation to affect wage inequality. As wages and international activities are closely linked to heterogeneous firm characteristics, exporting and FDI firms pay higher wages, and multinationals can be ranked at the top of this wage hierarchy.

The comparative statics exercise in this paper pointed out that the interdependence between labour market rigidities and firm's mode of foreign market entry, implies that changes in a country's labour market institution (such as a labour market reform) changes the pattern of trade and FDI within and across countries. Therefore, by adding multinational activity to the international trade analysis this paper enriches our ability to understand how labour market reforms can condition the relationship between diverse aspects of globalisation and labour market outcomes.

In summary, this paper provides a unified framework for analysing the complex interplay between diverse forms of globalisation, labour market frictions and wage inequality. In doing so I have built a theoretical model that is able to explain my empirical findings from the first chapter of my thesis. The theory explains positive exporter and multinational premia for employment and wages and predicts imperfect correlations between firm employment, wages and international activity.

The analysis further highlights a number of interesting areas for further research. Since some of the models predictions regarding wage inequality are ambiguous, a calibration of the model would enable us to sign some of the effects described in

the paper. Finally, I believe my framework has the potential to capture and explain the interdependence between firms international activities, institutional changes and labour market outcomes. Estimating the model with Data for Germany, is left for future research.

Bibliography

- Abowd, J. M., F. Kramarz, and D. N. Margolis (1999). High wage workers and high wage firms. *Econometrica* 67(2), 251–333.
- Amiti, M. and D. R. Davis (2011). Trade, firms, and wages: Theory and evidence. *The Review of economic studies* 79(1), 1–36.
- Anderson, J. E. and E. Van Wincoop (2004). Trade costs. *Journal of Economic literature* 42(3), 691–751.
- Antràs, P. and S. R. Yeaple (2014). Multinational firms and the structure of international trade. *Handbook of International Economics* 4.
- Axtell, R. L. (2001). Zipf distribution of us firm sizes. *science* 293(5536), 1818–1820.
- Baumgarten, D. (2013). Exporters and the rise in wage inequality: Evidence from german linked employer–employee data. *Journal of International Economics* 90(1), 201–217.
- Bernard, A. B., J. B. Jensen, and R. Z. Lawrence (1995). Exporters, jobs, and wages in us manufacturing: 1976-1987. *Brookings Papers on Economic Activity. Microeconomics*, 67–119.
- Bloom, N., R. Sadun, and J. Van Reenen (2012). Americans do it better: Us multinationals and the productivity miracle. *American Economic Review* 102(1), 167–201.

- Brainard, S. L. (1993). An empirical assessment of the proximity-concentration tradeoff between multinational sales and trade. Technical report, National Bureau of Economic Research.
- Card, D., J. Heining, and P. Kline (2013). Workplace heterogeneity and the rise of west german wage inequality. *The Quarterly journal of economics* 128(3), 967–1015.
- Coşar, A. K., N. Guner, and J. Tybout (2016). Firm dynamics, job turnover, and wage distributions in an open economy. *American Economic Review* 106(3), 625–63.
- Cuñat, A. and M. J. Melitz (2012). Volatility, labor market flexibility, and the pattern of comparative advantage. *Journal of the European Economic Association* 10(2), 225–254.
- Davidson, C., L. Martin, and S. Matusz (1999). Trade and search generated unemployment. *Journal of International Economics* 48(2), 271–299.
- Davidson, C., S. J. Matusz, and A. Shevchenko (2008). Globalization and firm level adjustment with imperfect labor markets. *Journal of international Economics* 75(2), 295–309.
- Dix-Carneiro, R. (2014). Trade liberalization and labor market dynamics. *Econometrica* 82(3), 825–885.
- Egger, H. and U. Kreickemeier (2009). Firm heterogeneity and the labor market effects of trade liberalization. *International Economic Review* 50(1), 187–216.
- Egger, H. and U. Kreickemeier (2013). Why foreign ownership may be good for you. *International Economic Review* 54(2), 693–716.
- Fabbri, F., J. E. Haskel, and M. J. Slaughter (2003). Does nationality of ownership

- matter for labor demands? *Journal of the European Economic Association* 1(2-3), 698–707.
- Fahr, R. and U. Sunde (2009). Did the hartz reforms speed-up the matching process? a macro-evaluation using empirical matching functions. *German economic review* 10(3), 284–316.
- Felbermayr, G., J. Prat, and H.-J. Schmerer (2011). Globalization and labor market outcomes: Wage bargaining, search frictions, and firm heterogeneity. *Journal of Economic theory* 146(1), 39–73.
- Fosfuri, A., M. Motta, and T. Rønde (2001). Foreign direct investment and spillovers through workers’ mobility. *Journal of international economics* 53(1), 205–222.
- Glass, A. J. and K. Saggi (2002). Multinational firms and technology transfer. *Scandinavian Journal of Economics* 104(4), 495–513.
- Görg, H., E. Strobl, and F. Walsh (2007). Why do foreign-owned firms pay more? the role of on-the-job training. *Review of World Economics* 143(3), 464–482.
- Grossman, G. M., E. Helpman, and P. Kircher (2017). Matching, sorting, and the distributional effects of international trade. *Journal of political economy* 125(1), 224–264.
- Gumpert, A. (2015). The organization of knowledge in multinational firms. *Journal of the European Economic Association*.
- Head, K. and J. Ries (2003). Heterogeneity and the fdi versus export decision of japanese manufacturers. *Journal of the Japanese and international economies* 17(4), 448–467.
- Helpman, E. and O. Itskhoki (2010). Labour market rigidities, trade and unemployment. *The Review of Economic Studies* 77(3), 1100–1137.

- Helpman, E., O. Itskhoki, M.-A. Muendler, and S. J. Redding (2017). Trade and inequality: From theory to estimation. *The Review of Economic Studies* 84(1), 357–405.
- Helpman, E., O. Itskhoki, and S. Redding (2010). Inequality and unemployment in a global economy. *Econometrica* 78(4), 1239–1283.
- Heyman, F., F. Sjöholm, and P. G. Tingvall (2007). Is there really a foreign ownership wage premium? evidence from matched employer–employee data. *Journal of International Economics* 73(2), 355–376.
- Horstmann, I. J. and J. R. Markusen (1992). Endogenous market structures in international trade (natura facit saltum). *Journal of international Economics* 32(1-2), 109–129.
- Hummels, D. and G. Schaur (2012). Time as a trade barrier. Technical report, National Bureau of Economic Research.
- Jacobi, L. and J. Kluve (2006). Before and after the hartz reforms: The performance of active labour market policy in germany.
- Lucas, R. E. (1978). On the size distribution of business firms. *The Bell Journal of Economics*, 508–523.
- Markusen, J. R. and A. J. Venables (2000). The theory of endowment, intra-industry and multi-national trade. *Journal of international economics* 52(2), 209–234.
- Martins, P. S. (2011). Paying more to hire the best? foreign firms, wages, and worker mobility. *Economic Inquiry* 49(2), 349–363.
- Melitz, M., E. Helpman, and S. Yeaple (2004). Export versus fdi with heterogeneous firms. *American Economic Review* 94.
- Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica* 71(6), 1695–1725.

- Navaretti, G. B., A. Venables, and F. Barry (2004). *Multinational firms in the world economy*. Princeton University Press.
- Ochel, W. (2005). Hartz iv—welfare to work in germany. *CESifo DICE Report* 3(2), 18–25.
- Saez, E. (2001). Using elasticities to derive optimal income tax rates. *The review of economic studies* 68(1), 205–229.
- Schank, T., C. Schnabel, and J. Wagner (2007). Do exporters really pay higher wages? first evidence from german linked employer–employee data. *Journal of international Economics* 72(1), 52–74.
- Shatz, H. J. and A. Venables (2000). *The geography of international investment*, Volume 2338. World Bank Publications.
- Song, J., D. J. Price, F. Guvenen, N. Bloom, and T. Von Wachter (2015). Firming up inequality. Technical report, National Bureau of Economic Research.
- Stole, L. A. and J. Zwiebel (1996). Intra-firm bargaining under non-binding contracts. *The Review of Economic Studies* 63(3), 375–410.
- Tomiura, E. (2007). Foreign outsourcing, exporting, and fdi: A productivity comparison at the firm level. *Journal of International Economics* 72(1), 113–127.
- Verhoogen, E. A. (2008). Trade, quality upgrading, and wage inequality in the mexican manufacturing sector. *The Quarterly Journal of Economics* 123(2), 489–530.

Chapter 3

Accounting for Skill Premia across Countries and Time

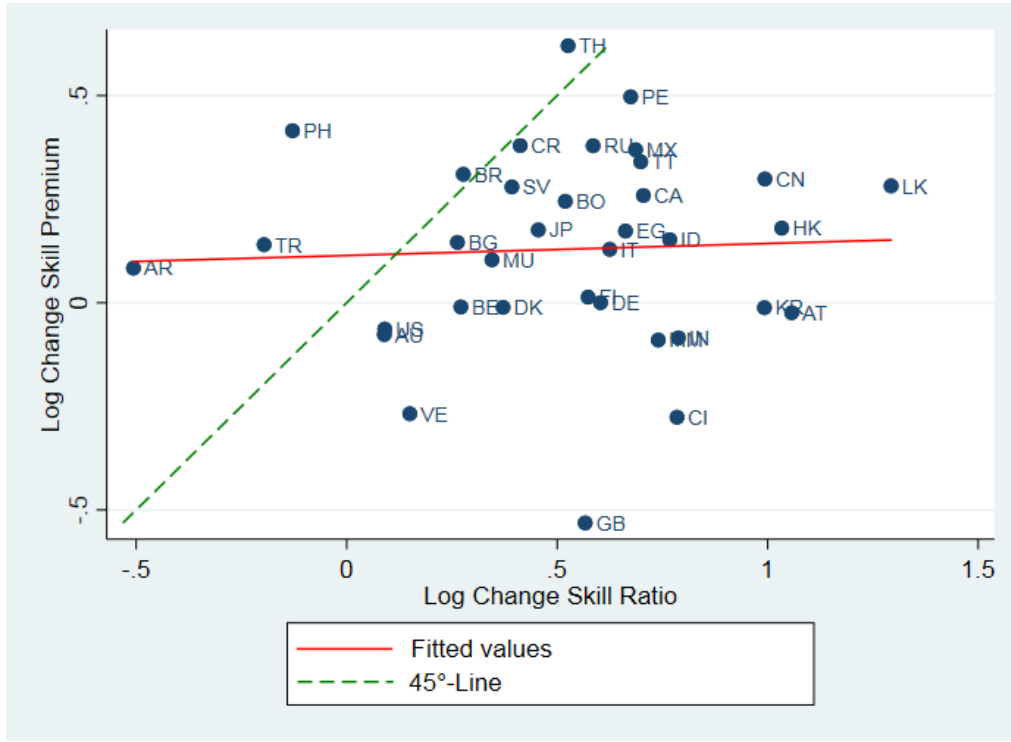
3.1 Introduction

Applying the basic economic principle of supply and demand in order to understand changes in the relative wage of skilled workers (skill-premium), predicts that an increase in the relative supply of skills ought to decrease the premium the labour market pays for skills. A closer look at recent developments of the skill premium in several countries, however, suggests that for some countries exactly the opposite is true.

Figure 1 illustrates the relationship between the log change in the skill premium and the log change in the share of individuals with completed tertiary education (skill ratio) for a sample of 36 countries between 1983 and 2007.¹ Clearly, despite the large increase in the share of educated people in most countries, the skill premium

¹The skill premium is defined as the ratio of the mean wage in a set of manufacturing occupations that are classified as high-skilled by the International Standard Classification of Occupations (ISCO-88), to the mean wage in a set of low-skilled occupations. The growth in the skill premium is calculated by calculating the relative change of two subperiods. I take 8-year averages, which defines the first (1983-1991) and the last subperiod (1999-2007), respectively.

has failed to decrease during the same period.



Notes: The figure shows the correlation between the log change in the relative skill supply and log changes in the skill premium. The regression coefficient is 0.01 (robust SE: 0.036), p-value of 0.807 and with R^2 of 0.001. Data are for a balanced panel of 36 countries in 8 year intervals between 1983-1991 and 1999-2007. See section 3.1 for a detailed description of data sources.

Figure 3.1: Relative changes in skill-supply and the skill-premium (1983-2007)

This puzzling observation calls for a closer investigation of the key factors shaping the evolution of the skill-premium across countries and time. I use the structure of a two-sector two-factor model to attribute changes in the skill premium across countries to three potential sources: (i) changes in the relative abundance of skilled workers, (ii) technological change and (iii) market size effects due to external economies of scale. In this model the production of final goods uses low and high-skilled labour, and a continuum of different varieties of intermediate inputs. Due to increasing returns to scale in the underlying production function, the model exhibits additional

market size effects, which are the source of the latter of the three effects.

I employ the development and growth accounting methodology as an analytic tool to assess the relative importance of each one of these channels in explaining cross-country skill premium changes.² In the context of the skill-premium analysis, I am asking the analogous question of how much of the variation in changes skill premium over time, can be explained by variations in the growth of countries' relative skill-supply and how much of cross-country skill-premium variation remains unexplained. Consequently, the unexplained fraction of the skill-premium must be attributed to technological change. My findings add to the growing evidence that there is hardly any association between changes in the relative supply of skills and the observed evolution of the skill-premium.

The most important results in this paper concern the relationship between market size effects and the observed patterns in the data. I show that the measure of the importance of market size effects governs the strength of the relationship between technological change and the skill-premium, where larger values of the importance of market size effects improve the goodness of fit substantially. Moreover, for strong enough economies of scale, an increase in the share of high-skilled workers increases the the skill premium. This observation may provide a potential explanation for the pattern of skill premia across countries and time, where skill premia were increasing despite the simultaneous rise in the relative supply of skills. Importantly, this finding points out that the scale of the economy may be an important factor in shaping developments of the skill premium, independent of the specific features of technological

²In the context of income differences across countries, development accounting assesses the relative contribution of differences in factor quantities, and differences in the efficiency with which those factors are used, to cross-country differences in per-worker incomes. Equivalently, growth accounting, as first implemented by Solow (1957), examines the different aspects of growth to determine which factor most likely created the increase in per-worker income. The development accounting literature usually refers to the unexplained variation of growth as technological progress, efficiency, or the measure of our ignorance (see Caselli (2005)).

change.

Related Literature.

This paper contributes to the large literature studying different determinants of wage inequality across countries and time. In particular, my analysis relates to a number of papers trying to explain the puzzling patterns between the increase in the skill premium and the simultaneous rise in the relative supply of skills across many countries. The main factors identified by the literature are skill-biased technological change and international trade.³

A paper that is particularly related to my analysis is Caselli and Coleman (2006). They perform a development accounting exercise to study cross country income and technology differences. They use information on the relative skill supply and data on the skill premium to back out the values for the high and low-skilled augmenting productivities.⁴ Hence, they report cross-country skill premium differences and analyse the resulting implications for technological change in the presence of barriers to technological adoption. While Caselli and Coleman (2006) study cross-sectional differences, my paper focuses on changes over time. Moreover, I analyse the role of market size effects, which is absent from their accounting exercise.

Another paper that is closely related in terms of the overall question is Acemoglu (2003), who analyses how skill premia differ over time and across countries. However, his paper is different in several ways. First, his paper is a purely theoretical contribution and second, in the model he develops, skill premia are not only determined by the relative supply of skills, but also by endogenous technological change and trade. In doing so, he focuses on different channels in explaining developments of the skill

³For example Acemoglu (1998) Acemoglu and Zilibotti (2001) Acemoglu (2002), Card and DiNardo (2002) and Gasparini et al. (2011) focus on skill-biased technological as the main determinant of inequality.

⁴Furthermore, the implied methodology relies on the fact that wages are informative about relative marginal productivities, which may not be the case given the large discrepancies in labour market institutions across countries.

premium. The most important result of his paper is that increased international trade induces skill-biased technical change. As a result, trade opening can cause a rise in inequality both in developed and the less developed countries.

Lastly, my paper relates to previous contributions studying the skill bias of scale, as proposed by Epifani and Gancia (2006) and Epifani and Gancia (2008). They show that the increase in market size can lead to higher skill premia and income inequality. Similar to the framework employed for my analysis, their mechanism is based on a two-sector, two-factor model. However, they assume that the more skill intensive sector exhibits stronger returns to scale. They show that an increase in the market size through trade increases the relative wage of skilled workers, as output increases relatively more in the skill-intensive sectors due to stronger economies of scale.

The structure of the paper is as follows. In section 2 I present the model, which serves as the basis of the skill-premium accounting exercise. Section 3 provides a description of the data and presents the results of the accounting exercise. In section 4 I discuss the implications of my findings, and section 5 concludes the paper.

3.2 The Model

3.2.1 Setup

This section outlines a basic two-factor two-sector model that captures the approximate determinants of the skill premium. The framework is based on a standard Dixit-Stiglitz formulation for a closed economy.

PREFERENCES

Consumers have preferences represented by a utility function which is defined over a constant elasticity of substitution (CES) aggregate of a low-skill intensive and a high-skill intensive good

$$U_t = \left[\sigma_L C_{Lt}^{\frac{\theta-1}{\theta}} + \sigma_H C_{Ht}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \quad (3.1)$$

where $\theta > 1$ is the elasticity of substitution between the two final goods. C_{Lt} and C_{Ht} stand for the consumption of the low-and high-skill intensive good in year t . Furthermore, σ_i is a parameter capturing the relative importance in consumption of the i -intensive good ($i \in L, H$), where $\sigma_L + \sigma_H = 1$.

Technologies and Market Structure

Production of final goods uses low (L_{it}) and high-skilled labour (H_{it}), and a continuum of different varieties of intermediate inputs indexed by $m \in [0, M_{it}]$, with M_{it} being the aggregate measure of input varieties. The production technology of industry i can be summarized by the total cost function B_{it} of producing Q_{ti} final good and the cost function $b_{it}(m)$ of producing $q_{it}(m)$ units of variety m of the intermediate inputs used in industry i in period t ,

$$B_{it} = \left[\frac{1}{Z_{it}} \left(\frac{w_{Lt}}{1 - \alpha_i} \right)^{1-\alpha_i} \left(\frac{w_{Ht}}{\alpha_i} \right)^{\alpha_i} \right]^{1-\beta} \times \left[\int_0^{M_{it}} p_{it}(m)^{1-\varepsilon} dm \right]^{\frac{\beta}{(1-\varepsilon)}} Q_{it} \quad (3.2)$$

$$b_{it}(m) = \frac{1 + q_{it}(m)}{Z_{it}} \times \left(\frac{w_{Lt}}{1 - \alpha_i} \right)^{1-\alpha_i} \left(\frac{w_{Ht}}{\alpha_i} \right)^{\alpha_i} \quad (3.3)$$

where $0 \leq \beta \leq 1$ captures the relative importance of intermediate inputs in the production of sector i , $0 \leq \alpha_i \leq 1$ is the share of skilled workers employed in industry i , $\varepsilon > 1$ denotes the elasticity of substitution between input varieties and Z_{it} is an exogenous industry-productivity measure. In the following we will assume that $\alpha_H > \alpha_L$, i.e. that industry $i = H$ is skill-intensive relative to industry $i = L$. With perfectly mobile labour the competitive wage workers receive is denoted by w_{it} . Equation (2) states that the technology to produce the final good of industry i is a Cobb-Douglas function on low and high-skilled workers, and intermediate inputs. Equation (3) implies that the production technology of intermediate inputs is also a Cobb-Douglas function on the two different types of workers and that there are fixed and variable costs.

The labour market is assumed to be perfectly competitive. The market for the final goods Q_{it} operates under perfect competition, whereas the market for intermediate inputs exhibits monopolistic competition.

3.2.2 Equilibrium

Prices

The production function of final goods in equation (2) exhibits constant returns. Under perfect competition the price is given by the marginal cost of a good, given by

$$P_{it} = \frac{\partial B_{it}}{\partial Q_{it}} \quad (3.4)$$

Moreover, the representative household's utility maximisation from equation (1) implies the following relationship between the relative price and the relative inverse

demand of a good:

$$\frac{P_{Ht}}{P_{Lt}} = \frac{\sigma_H}{\sigma_L} \left[\frac{C_{Lt}}{C_{Ht}} \right]^{\frac{1}{\theta}} \quad (3.5)$$

Choosing the final output as the numeraire, the price index P in the economy for a given period t can be expressed by

$$P = \left[\sigma_L^\theta P_{Lt}^{1-\theta} + (1 - \sigma_L)^\theta P_{Ht}^{1-\theta} \right]^{\frac{1}{1-\theta}} = 1 \quad (3.6)$$

Intermediate goods producers are assumed to operate under monopolistic competition with free entry. This implies that the profit maximising price is being set according to the following 'markup rule'

$$p_{it}(m) = \left(\frac{\varepsilon}{\varepsilon - 1} \right) \frac{\partial b_{it}(m)}{\partial q_{it}(m)} \quad (3.7)$$

Market clearing

Market clearing conditions for the goods and labour market by the following set of equations:

$$P_{it}Q_{it} = E_{it} \quad (3.8)$$

which states that the aggregate supply of each good matches its demand, where $E_{it} = P_{it}C_{it}$ is the aggregate expenditure on the i -intensive good . The expression for aggregate demand of low- (L_t) and high-skilled (H_t) are given by

$$L_t = \sum L_{it} \quad \text{with} \quad L_{it} = L_{it}^Q + L_{it}^q \quad (3.9)$$

$$H_t = \sum H_{it} \quad \text{with} \quad H_{it} = H_{it}^Q + H_{it}^q \quad (3.10)$$

where L_{it} and H_{it} are the number of low and high-skilled workers demanded by industry i . Furthermore, low- and high-skilled workers producing the final good in industry i can be denoted as L_{it}^Q and workers engaged in the production of intermediate inputs as L_{it}^q . Likewise, H_{it}^Q and H_{it}^q , represent the number of high-skilled workers engaged in producing final goods and intermediate goods respectively. Equations (9) and (10) imply that aggregate supply of high and low-skilled labour must equal their demands.

Next, we can find an expression of output Q_{it} as a function of the measure of input varieties M_{it} :⁵

$$Q_{it} = M_{it}^\mu \left(\frac{\varepsilon}{\varepsilon - 1} \right)^{-\beta} \frac{\varepsilon}{\beta} \quad (3.11)$$

where $\mu = 1 + \beta/(\varepsilon - 1)$. It is clear to see that the production function in (11) exhibits increasing returns to scale if the parameter $\mu > 1$; i.e. an increase in the available number of varieties M_{it} , through an increase in the market size, increases output over proportionally. Thus, μ can be interpreted as a measure of the importance of market size effects. Intuitively, this implies that a larger market benefits from external economies of scale as they tend to have a larger number of varieties of goods and inputs available.⁶ The following section determines the equilibrium skill-premium with ($\mu > 1$) and without ($\mu = 1$) market size effects. In doing so,

⁵See Appendix for the derivation of equation (11).

⁶Note, that economies of scale effects only depend on ε and do not directly come from the presence of fixed costs at the firm level. Epifani & Gancia (2006, 2008) show that 'external economies of scale' (from the firm perspective) are a good proxy for the latter. Especially Epifani and Gancia (2006), review evidence showing that high-skilled workers, in any country, are employed in sectors where plant-level fixed costs are high, and produce highly differentiated goods that are gross substitutes for less-skill-intensive products. Given these findings, their theory implies that scale is skill-biased, thereby providing a micro foundation for the perpetual increase in the relative demand for skilled workers.

we will be able to identify to what extent market size effects play a role in shaping skill-premium differences across countries and time.

Skill Premium

Defining the wage rate for skilled labour as w_{Ht} and w_{Lt} as the wage rate for unskilled labour in a frictionless labour market, the relative wage of high skilled workers can be expressed by using the relative price from equation (4) and relative demand of a good from equation (10). Hence, the above system (1)-(10) implies the following expression for the skill-premium:

$$\frac{w_{Ht}}{w_{Lt}} = \left(\frac{\eta_H}{\eta_L} \frac{Z_{Ht}}{Z_{Lt}} \right)^{\frac{1}{(\alpha_H - \alpha_L)}} \left(\frac{M_{Ht}}{M_{Lt}} \right)^{\frac{(\theta-1)\mu-\theta}{\theta(\alpha_H - \alpha_L)}} \quad (3.12)$$

where $\eta_i = \sigma_i (1 - \alpha_i)^{1-\alpha_i} \alpha_i^{\alpha_i} \beta^{\frac{1}{\theta}} / \left[\varepsilon^{\frac{1+(\theta-1)\beta}{\theta}} (\varepsilon - 1)^{\beta \frac{\theta-1}{\theta}} \right]$. Next, solving for the equilibrium expressions of M_H and M_L in equation (11) yields the following equation for the skill-premium:⁷

$$\frac{w_{Ht}}{w_{Lt}} = \left(\frac{\psi_H}{\psi_L} \frac{Z_{Ht}}{Z_{Lt}} \right)^{\frac{1}{(\alpha_H - \alpha_L)}} \left(\frac{(1 - \alpha_L) \frac{H_t}{L_t} \frac{w_{Ht}}{w_{Lt}} - \alpha_L}{\alpha_H - (1 - \alpha_H) \frac{H_t}{L_t} \frac{w_{Ht}}{w_{Lt}}} \right)^{\frac{(\theta-1)\mu-\theta}{\theta(\alpha_H - \alpha_L)}} \quad (3.13)$$

where $\psi_i = \sigma_i^{\theta/(\theta-1)\mu} (1 - \alpha_i)^{(1-\alpha_i)} \alpha_i^{\alpha_i}$. Equations (12) and (13) highlight three potential channels through which the skill-premium can be affected: changes in relative industry productivities Z_{Ht}/Z_{Lt} , the share of skilled workers H_t/L_t , and an increase in the market sizes, captured by M_{Ht} and M_{Lt} . Equation (13) implies that *ceteris paribus* the skill-premium is decreasing in the relative supply of skills H_t/L_t , as long as $\frac{(\theta-1)\mu-\theta}{\theta} < 0$. In other words, in order for the skill premium and relative skill supply to be inversely correlated, it has to be true that $\mu < \frac{\theta}{(\theta-1)}$. Moreover, for

⁷See Appendix for the derivation of equation (13).

a given supply of skills the skill-premium also depends on relative industry productivities Z_{Ht}/Z_{Lt} and hence, an increase in the relative industry specific efficiency with which labour is used, tends to increase the relative wage of high skilled workers. For simplicity, I subsequently assume that the high-skill intensive industry uses only high-skilled workers and the low-skill intensive industry only low-skilled workers respectively (i.e. $\alpha_H = 1$ and $\alpha_L = 0$).

3.2.3 Special Cases

Special Case: No market size effects ($\mu = 1$)

In order to understand the importance of the measure of market size effects μ in shaping skill-premium developments, I first consider the special case where $\mu = 1$, i.e. market size effects are entirely absent. Under the above mentioned condition, i.e. $\alpha_H = 1$ and $\alpha_L = 0$, we can find an explicit expression of the skill-premium in terms of relative industry productivities Z_{Ht}/Z_{Lt} and relative factor endowments H_t/L_t . In this polar case the expression for the log relative wage of high skilled workers simplifies to

$$\ln \left(\frac{w_{Ht}}{w_{Lt}} \right) = \frac{(\theta - 1)}{\theta} \ln \left(\frac{\sigma_H}{\sigma_L} \right) + \frac{(\theta - 1)}{\theta} \ln \left(\frac{Z_{Ht}}{Z_{Lt}} \right) - \frac{1}{\theta} \ln \left(\frac{H_t}{L_t} \right), \quad (3.14)$$

Concerning this equation, two observations stand out: First, the inverse of the elasticity of substitution in consumption θ can now be interpreted as the elasticity of the skill-premium with respect to the relative supply of skills.⁸ Second, the simplified formulation in equation (14) suggests that the relative importance in consumption of high-skill intensive goods in the economy may be another important factor in determining the skill-premium; i.e. a rise in the importance in consumption of the

⁸The special feature of this kind of specific-factor model is that, the elasticity of substitution in consumption also coincides with the elasticity of substitution between high and low skilled workers.

high-skill intensive good σ_H causes the skill-premium to increase. Intuitively, this means that the demand for skilled workers increases the higher its relative demand within the economy, resulting in higher relative wages for skilled workers. As in equation (13) the positive relationship between the relative wage of high skilled workers and relative industry productivities remains.

General Case: The role of market size effects ($\mu > 1$)

Next, we turn to the more general case, where market size effects, through $\mu > 1$, are present. As in the special case without market size effects, we here assume that $\alpha_H = 1$ and $\alpha_L = 0$. The skill-premium is now given by

$$\ln \left(\frac{w_{Ht}}{w_{Lt}} \right) = \frac{(\theta - 1)\mu}{\theta} \ln \left(\frac{\sigma_H}{\sigma_L} \right) + \frac{(\theta - 1)\mu}{\theta} \ln \left(\frac{Z_{Ht}}{Z_{Lt}} \right) + \frac{(\theta - 1)\mu - \theta}{\theta} \ln \left(\frac{H_t}{L_t} \right), \quad (3.15)$$

This equation makes clear that introducing market size effects ($\mu > 1$) reduces the responsiveness of the skill-premium to changes in the supply of high-skilled workers. As pointed out in the special case without market size effects, an increase in the relative supply of skills lowers relative wages with elasticity $1/\theta$. Hence in the more general case with $\mu > 1$ the elasticity is given by

$$\frac{\partial \ln(w_H/w_L)}{\partial \ln(H/L)} = \frac{(\theta - 1)\mu - \theta}{\theta} \quad (3.16)$$

Therefore, for a given level of RTFP the implied relative demand curve for high vs low skilled workers is downward sloping if the elasticity implied by (16) is negative.

3.3 Accounting for Skill-Premium Changes

This section is about determining and quantifying to what extent the individual channels, i.e. changes in the relative scarcity of high-skilled workers and relative industry productivities, contribute to changes in the skill-premium across countries. Furthermore, I will explore the way market size effects play a role in shaping the observed results. This accounting exercise is very similar to the one in the development and growth accounting literature. Development accounting assesses the relative contribution of differences in factor quantities, and differences in the efficiency with which those factors are used, to cross-country differences in per-worker incomes.

Equivalently, growth accounting allows one to examine the different aspects of growth to determine which factor most likely created the increase in per-worker income. Using the growth accounting methodology in the context of the skill-premium analysis is a powerful tool that enables us to identify the proximate sources of changes in the skill-premium. In other words, I am asking the question of how much of the variation in changes in the skill premium over time, can be explained by variations in the growth of countries' relative skill-supply and how much of cross-country skill-premium variation remains unexplained. Consequently, the unexplained fraction of the skill-premium must be attributed to changes in relative industry productivities. Given the simplified framework, as in equation (14) and (15), this residual variation, also called the 'measure of ignorance' (see Caselli (2005)), may not only capture differences in efficiencies with which labour is used, but also other omitted factors, such as changes in the demand for skills.

The following section is structured as follows: first, I will present the data sources and parametrisation strategy of this accounting exercise and second, I will implement the accounting exercise (i) without market size effects ($\mu = 1$) and (ii) in the presence

of market size effects ($\mu > 1$).

3.3.1 Data Sources

In order to perform the accounting exercise we need data on the skill premium (w_H/w_L) and the relative supply of skills (H/L), as well as calibrated values for the elasticity of substitution in demand (θ) and the importance of market size effects (μ), which is central to my accounting exercise.

Skill Premium

The empirical counterpart of the skill premium (w_H/w_L) can be constructed by using wage data for different occupations, where the skill-premium can be defined as the ratio of the mean wage in a set of high-skill to low-skill occupations. The occupational wage data come from the updated *Occupational Wages Around the World* (OWW) database by Freeman and Oostendorp (2005), which contains occupational wages for 161 occupations in 171 countries from 1983 until 2008. The data for their study were derived from the ILO October Inquiry, which collects information on pay (wages, earnings, and hours of work) across detailed occupations at the four-digit International Standard Classification of Occupations (ISCO88) level. The scope of the ILO October Inquiry has been increasing since its inception in 1924, both in country coverage and in number of occupations included. So far, the ILO October Inquiry is the most far-ranging survey of wages by occupations around the world. However, due to the lack of comparability in reported wage formats across countries and over time, the ILO dataset is not directly usable. Freeman and Oostendorp (2005) constructed the OWW database by standardising data derived from the ILO October Inquire database, such that wages could be made comparable across occupations, countries and over time.⁹

⁹Freeman and Oostendorp (2005) use several different ways to impute the occupational wage data, but the occupational wages from the different approaches are highly correlated. The present

However, the data is very unbalanced in that countries rarely report wages for all occupations in all years, which limits the size of my sample to 36 countries. Moreover, it should be noted that, although *OWW* represents a significant improvement in standardising the data, Freeman and Oostendorp (2005) rely to a high degree on data correction, calibration and imputation to standardise the occupational wage data from the ILO dataset. For example, some countries report more than one wage for a single occupation, others give wages for one gender only, or only for the dominant economic region. Another issue is the fact that countries report wages in different formats, i.e. either hourly, monthly or some only report minimum wages.

Relative Skill Supply

A variable that has played a prominent role in the development-accounting literature and which I am going to employ for the same purpose, is the measure of relative skill supply from the Barro and Lee (2013) dataset of educational attainment in the world. The Barro and Lee (2013) database provides educational attainment data for 146 countries in 5-year intervals from 1950 to 2010. Their key sources of raw data to build measures of skilled and unskilled labor supply come from census/survey information, as compiled by UNESCO, Eurostat, and other sources. The census/survey figures report the distribution of educational attainment in the population over age 15 by sex and by 5-year age group, for most cases, in seven categories: (1) no formal education, (2) incomplete primary, (3) complete primary, (4) lower secondary, (5) upper secondary, (6) incomplete and (7) complete tertiary.

study employs their occupation wages in U.S. dollars with country-specific and uniform calibration, type 3, lexicographic weighting (x3wlus in their data set). See Freeman and Oostendorp (2005) for a detailed description of how the *OWW* data file is being constructed.

3.3.2 Data Description and Parameters

Data

Table 3.1: Summary Statistics for w_H/w_L

Subsample	Obs	Min	Mean	Max	Std. Dev.
1983-1991	36	0.77	1.53	2.82	0.47
1999-2007	36	0.78	1.77	3.85	0.66
$\frac{d(w_H/w_L)}{w_H/w_L}$	36	-0.41	0.17	0.86	0.26

I use the provided hourly wages from the updated *OWW* dataset to calculate the skill premium as the ratio of the mean wage in a set of manufacturing occupations that are classified as high-skilled by the International Standard Classification of Occupations (ISCO-88), to the mean wage in a set of low-skilled occupations. Further, I divide the sample into two periods; i.e $t = 1, 2$: first, the average skill premium in the first 8 years (w_{H1}/w_{L1}) (i.e. 1983-1991) and second, the respective value in the last 8 years (w_{H2}/w_{L2})(1999-2007). In using 8 year averages I am able to control and smooth out (at least to some extent) potential measurement errors, outliers in a particular year and common macro changes. The choice of countries is mainly dictated by the availability of data. More specifically, the countries selected for the sample are those, where the average manufacturing skill premium and the relative supply of skilled workers exist for the first and last 8 years of the sample. This leaves us with 36 countries in total.¹⁰

Furthermore, I choose the relative supply of high-skilled workers, to match the share of tertiary schooling attained in the population (i.e. university graduates with degrees and post-graduates) from the Barro and Lee (2013) dataset. Table 1 dis-

¹⁰See Appendix for the list of countries in the sample.

Table 3.2: Summary Statistics for $H/(H + L)$

Subsample	Obs	Min	Mean	Max	Std. Dev.	Corr w_H/w_L
1983-1991	36	0.008	0.06	0.23	4.93	-0.24
1999-2007	36	0.001	0.10	0.25	7.12	-0.21
$\frac{d(H/(H+L))}{H/(H+L)}$	36	-0.87	0.74	2.62	0.68	0.04

plays the summary statistics for w_H/w_L and Table 2 for $H/(H + L)$ respectively. Moreover, Figure 1 depicts the relationship between relative changes in skill premia and the relative supply of skills.

Paramatrisation

In the baseline version, the skill intensity in the high-skill intensive sector is given by $\alpha_H = 1$, and in the low-skill intensive sector by $\alpha_L = 0$ respectively.

For the elasticity of substitution between input varieties (ε), I use the median value estimated by Feenstra and Romalis (2014), which is set at 6.07. Epifani and Gancia (2008) use a similar model specification based on a two sector - two factor framework as the one I employ and provide estimates for the elasticity of substitution in demand (θ) between 1-2. Thus, here I choose the average value of $\theta = 1.5$.

Lastly, the measure of importance of market size effects (μ) is taken from Broda et al. (2006), who estimate the impact of new varieties on GDP using highly disaggregated trade data. They find that a one percent increase in the number of varieties raises GDP by 0.14 percent. This estimate implies that here $\mu = 1.14$

Table 3 summarises data sources and the parametrisation strategy.

Table 3.3: Data and Paramatrisation Strategy

Data & Parameters	Value	Description	Source
w_H/w_L	data	Skill-Premium	Freeman and Oostendorp (2005)
$H/(H + L)$	data	Relative supply of skilled workers	Barro and Lee (2013)
θ	1.5	Elasticity of substitution in demand	Epifani and Gancia (2008)
μ	1.14	Importance of market sizes effects	Broda et al. (2006)
α_H	1	Share of high-skilled workers in the high skill-intensive industry	-
α_L	0	Share of high-skilled workers in the low skill-intensive industry	-

3.3.3 Accounting Methodology

In order to perform an equivalent growth accounting exercise of the skill premium, I will first rewrite equation (15) in terms of relative changes between the first and second subperiod,

$$\left(\frac{\hat{w}_H}{w_L}\right) = \frac{(\theta - 1)\mu}{\theta} \left(\frac{\hat{Z}_H}{Z_L}\right) + \frac{(\theta - 1)\mu - \theta}{\theta} \left(\frac{\hat{H}}{L}\right), \quad (3.17)$$

where a 'hat' above the different terms indicates relative changes; i.e. $(w_H/\hat{w}_L) = \frac{\Delta(w_H/w_L)}{(w_H/w_L)}$, $(H/\hat{H}) = \frac{\Delta(H/L)}{(H/L)}$ and $(Z_H/\hat{Z}_L) = \frac{\Delta(Z_H/Z_L)}{(Z_H/Z_L)}$. Equation (16) further implies that the unobservable term (Z_H/\hat{Z}_L) can be inferred from the data on the observable variables; namely (i) the relative change in the skill-premium (w_H/\hat{w}_L) and (ii) the relative change in the supply of high-skilled workers (H/\hat{H}) .

Rearranging equation (17) for (Z_H/\hat{Z}_L) yields the following expression for the

relative change in RTFP:

$$\left(\frac{\hat{Z}_H}{\hat{Z}_L}\right) = \frac{\theta}{(\theta-1)\mu} \left(\frac{\hat{w}_H}{w_L}\right) - \frac{(\theta-1)\mu - \theta}{(\theta-1)\mu} \left(\frac{\hat{H}}{L}\right). \quad (3.18)$$

Hence, changes in RTFP are entirely pinned down by equation (18), implying that (\hat{Z}_H/\hat{Z}_L) is chosen to fit the theoretical relationship between the observed relative changes in the skill-premium and changes in the relative skill supply.

Next, I define the known term in equation (15) as $(w_H/\hat{w}_L)^S = -((\theta-1)\mu - \theta)/\theta)(\hat{H}/L)$, and $(\hat{Z}_H/\hat{Z}_L)^S = ((\theta-1)\mu/\theta)(\hat{Z}_H/\hat{Z}_L)$, which I will refer to as the 'skill-supply model'. We can then rewrite equation (17) as

$$\left(\frac{\hat{w}_H}{w_L}\right) = \left(\frac{w_H}{w_L}\right)^S + \left(\frac{\hat{Z}_H}{\hat{Z}_L}\right)^S \quad (3.19)$$

Based on this equation I can pursue the following skill-premium accounting question: How successful is the 'skill-supply model' in explaining the observed growth of skill-premium across countries? To perform this assessment I will look at a simple variance decomposition of equation (19), given by

$$Var\left(\frac{\hat{w}_H}{w_L}\right) = Var\left(\frac{w_H}{w_L}\right)^S + Var\left(\frac{\hat{Z}_H}{\hat{Z}_L}\right)^S + 2Cov\left(\left(\frac{w_H}{w_L}\right)^S, \left(\frac{\hat{Z}_H}{\hat{Z}_L}\right)^S\right), \quad (3.20)$$

A look at this equation makes clear that if more of the cross-country variation in changes of the skill-premium have to be attributed to changes in RTFP, less of the variation in (w_H/\hat{w}_L) can be explained by variations in changes of countries' relative skill-supply. this in turn, implies that much of the skill-premium changes are due to other omitted factors, such as changes in efficiencies with which labour is used or changes in the demand for skilled workers. Hence, the share of cross-country variation in (w_H/\hat{w}_L) which must be attributed to the variation in the backed out

relative changes in RTFP, is a suitable '*measure of ignorance*', given by

$$ignorance \equiv \frac{Var\left(\frac{\hat{z}_H}{\hat{z}_L}\right)^S}{Var\left(\frac{\hat{w}_H}{\hat{w}_L}\right)}, \quad (3.21)$$

A perfect match between theory and data would be depicted by a measure of ignorance equal to 0.¹¹

3.3.4 Accounting with $\mu = 1$

Table 4 presents the results of this skill-premium accounting assessment for the special case of no market size effects ($\mu = 1$), confirming what the summary statistics in Tables 1 and 2 jointly point out: despite the fact that the relative supply of skills has increased markedly in the last decades, the skill-premium has failed to decline during the same period. This finding has important implications: changes of the relative supply of skill do not seem to adequately capture changes in the skill-premium across countries.

Table 3.4: Summary Statistics for changes in RTFP ($\mu = 1$)

	Obs	Min	Mean	Max	Var	<i>ignorance</i>
Full Sample	36	-1.28	1.99	6.27	2.59	38.08
High-Income Countries	12	-0.03	1.64	4.23	1.98	61.88
Low-Income Countries	24	-1.28	2.12	6.27	2.90	40.81

As the figures in Table 4 suggest, the missing link here is technological change, i.e. changes of the skill-premium across countries have to be attributed to changes in RTFP. While the observed variance of the relative change in the skill premium is

¹¹Alternatively, we could assess this skill premium-accounting exercise by looking at the *measure of success* as in Caselli (2005), which compares the variation in changes in the supply of skills to the cross-country variation in the relative change of the skill-premium.

small, the heterogeneity in (Z_H/\hat{Z}_L) , according to this accounting exercise, is very large. This explains the relatively large value for the measure of ignorance, which is equal to 38.08 for the special case of no market size effects. We can therefore conclude that a simple framework that only incorporates the supply side of skills, does not adequately capture changes in the skill-premium across countries.

Having a closer look at the bottom two rows of Table 4, reveals that although the implied variation in RTFP is larger in low-income countries, the measure of ignorance is greater for high-income countries. This, in turn, implies that the observed heterogeneity in skill premia among high-income countries is smaller than the analogous variation among low-income countries. The smaller value of σ for low-income countries implies that the skill-supply model does a better job in explaining cross-country changes of the skill premium for this subsample than for high-income countries.

Moreover, the positive mean change in RTFP, suggests that technological change in the high-skill intensive industry is on average larger than in the low skill-intensive industry. This observation is in line with Kahn and Lim (1998), who find strong evidence that productivity growth was increasingly concentrated in the more skill-intensive manufacturing industries.¹²

3.3.5 Accounting with $\mu > 1$

Table 5 presents the analogous accounting exercise for the case with market size effects ($\mu > 1$). Given the parameter values according to the parametrisation strategy as described in section 3.2, the value of the measure of market size effects takes 1.14. The summary statistics for the implied relative changes in RTFP are depicted

¹²Haskel and Slaughter (2002) provide a theoretical framework for this so called 'sector bias' of technological change. The intuition behind sector bias relies on changes in the relative profitability of sectors. Any sector-specific technological change makes that sector profitable at fixed product prices and initial factor prices. Given fixed labour supply, relative wages adjust until the profit opportunities are arbitrated away.

in Table 5. Similar to the special case with $\mu = 1$, the cross-country heterogeneity in changes in RTFP are large: the values range between -1.03 and 5.24 and the necessary mean increase in RTFP takes a value of 1.68. Furthermore, Table 5 suggests that in the presence of market size effects, the necessary variation in changes in RTFP is now slightly lower. This finding is in line with the discussion related to equation (14), i.e. for higher values of μ , $\left(\frac{\hat{w}_H}{w_L}\right)$ becomes less responsive to changes in the relative scarcity of skills. Consequently, by increasing μ from 1.0 to 1.14, less variation in technological change is required to capture the observed cross-country skill-premium changes in the data, represented by a lower level of *ignorance* = 27.02.

Table 3.5: Summary Statistics for changes in RTFP for $\mu = 1.14$

	Obs	Min	Mean	Max	Var	<i>ignorance</i>
Full Sample	36	-1.03	1.68	5.24	1.84	27.02
High-Income Countries	12	-0.04	1.36	3.52	1.40	43.75
Low-Income Countries	24	-1.03	1.84	5.24	2.05	28.87

The results so far confirm what Figure 1 already suggested: There is hardly any association between changes in the skill premium and changes in the relative supply of skills. This finding is in particular true for high-income countries, as suggested by the relatively larger values for the measure of *ignorance*. Moreover, introducing market size effects, i.e. $\mu > 1$, reduces the need for changes in RTFP to explain the data. In the next section I will further explore the relationship between this parameter and the overall model performance in capturing the cross-country variation in skill premium changes.

3.4 Discussion

3.4.1 Market size effects and the measure of *ignorance*

The skill premium accounting exercise in the previous section was performed for two specific values of μ , i.e. $\mu = 1.0$ and $\mu = 1.14$. In this section I assess the model-fit for different values μ . The relationship between the measure of *ignorance* and the measure of the importance market size effects is summarised in Figure 2 and Table 6. The Figure confirms the above finding: the higher the value for μ the lower the level of *ignorance*, where the vertical dotted line depicts $\mu = 1.14$, which is the value for μ given the parameters as outlined in the parametrisation strategy. As the measure of ignorance is highest in the polar case ($\mu = 1.0$), the model with no market size effects can be regarded as the lower bound (see Table 6).

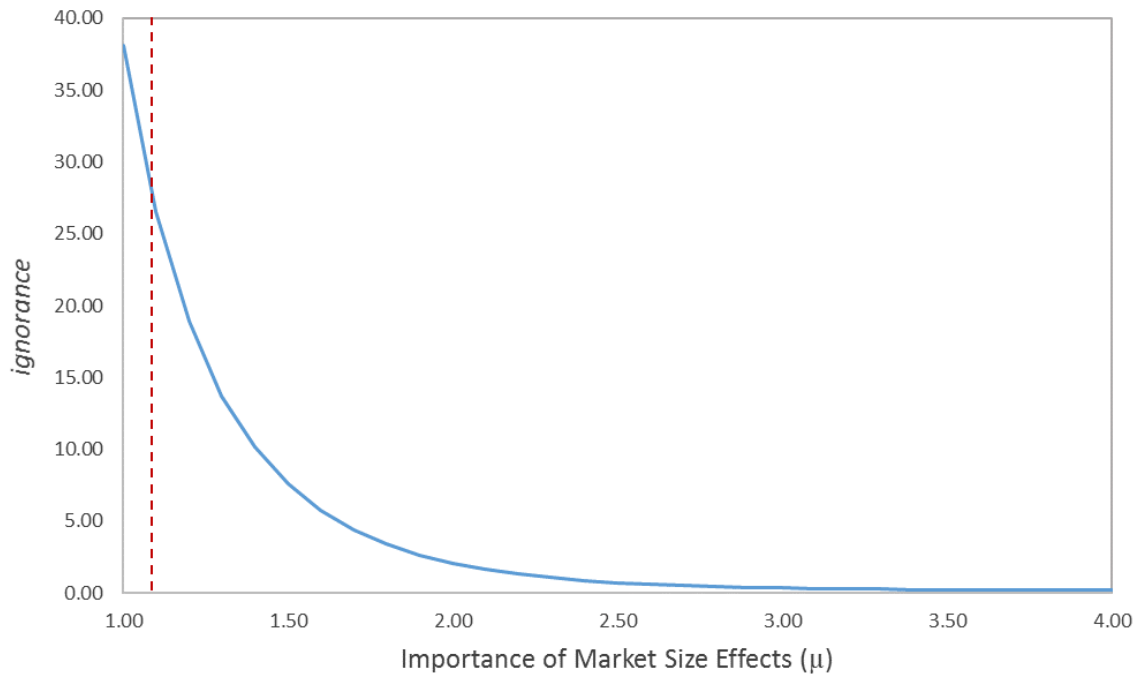


Figure 3.2: The measure of *ignorance* and the importance of market size effects (μ)

The results have important implications. For a given elasticity of substitution between high - and low-skilled workers (θ), a higher value of μ implies that less of a change in RTFP is required to explain the observed changes in the skill premium. Looking at equation (17), it becomes clear why this is the case: Changes in μ imply that the skill premium becomes less sensitive to changes in the relative supply of skills.

The results above were driven by the fact that - given the implied value of μ - the relationship between (w_H/\hat{w}_L) and (H/\hat{L}) in the data is weaker than the relationship implied by the model. In order to reconcile the changes observed in the data with the 'skill-supply model', countries with a large increase in the share of high-skilled workers must also have a large increase in RTFP. Therefore, with higher values of μ the skill premium becomes less responsive to changes in the relative supply of skills and thus, closer to the empirical one. This in turn explains the negative relationship between the measure of *ignorance* and the parameter μ .

Table 3.6: *ignorance* and the importance of market size effects (μ)

	$\mu = 1.0$	$\mu = 1.14$	$\mu = 1.5$	$\mu = 2.0$	$\mu = 2.5$	$\mu = 3.0$	$\mu = 3.5$
<i>ignorance</i>	38.08	27.02	11.38	4.15	1.77	1.00	0.85

Furthermore, for large enough values of μ , an increase in the share of high-skilled workers increases the the skill premium. Taking into consideration the expression for the elasticity of the skill premium with respect to the relative supply of skills in (16), clarifies that for $\mu \geq \theta/(\theta - 1)$ the negative relationship between relative skill supply and the skill premium no longer holds. This observation provides a potential explanation for the pattern of skill premia across countries and time, where skill premia were increasing despite the simultaneous rise in the relative supply of skills.

3.4.2 Interpretation and Implications

The analysis above highlights that market size effects govern the strength of the relationship between technological change and the skill-premium. My findings suggest that the larger the market size effect the less we need technological change in order to explain patterns in the data, i.e. a higher value for μ implies lower levels of *ignorance*. However, reasonable estimates of market size effects (1.14) are not large enough to explain the observed skill premium patterns in the data.

The lower bound for μ is equal to one, which represents the case where the economy operates under constant returns to scale. In the model this is captured by setting $\beta = 0$, which implies that we exclude intermediate inputs in the production process and hence, shut down the source for market size effects. As discussed above, $\mu = 1.0$ the highest level of *ignorance*.

Table 6 presented different levels of the measure of *ignorance* for varying degrees of market size effects. The question, however, arises what the upper bound on μ ought to be. Suppose $\beta = 1$, which represents a model of full monopolistic competition à la Krugman (1980, 1991). Estimates of the elasticity of substitution between varieties suggest an average value of about $\varepsilon = 6$ (i.e. $\mu = 1.2$) and the lower range lies at about $\varepsilon = 2$, implying $\mu = 2$. The measure of *ignorance*, in turn, then takes a value of 4.12, which is still relatively large.¹³ Hence, even for the upper bound of plausible values for μ , technological change would have to explain the major share of variation in skill premia across countries and time. Consequently, for plausible parameterisations, market size effects can help to explain the observed patterns in the data. However, overall technological change is the main factor.

¹³See for example Feenstra (1994), Morrison Paul and Siegel (1999) and Broda et al. (2006) for studies which provide estimates for the elasticity of substitution between varieties.

3.5 Conclusion

In this paper I shed some light on the proximate determinants of changes in the skill-premium. My findings add to the growing evidence that there is hardly any association between changes in the relative supply of skills and the observed evolution of the skill-premium. Furthermore, I show that the measure of the importance of market size effects governs the strength of the relationship between technological change and the skill-premium. Moreover, for strong enough economies of scale, an increase in the relative supply of skills increases the skill premium. Importantly, this finding points out that the scale of the economy may be an important factor in shaping developments of the skill premium, independent of the specific features of technological change.

A central parameter in the analysis of this paper is the measure of the importance of market size effects, which more generally captures the presence of economies of scale in the economy. The analysis has shown that even for the upper bound of plausible market size effects, technological change plays the main role in explaining the observed skill premium patterns. Potentially, market size effects play a greater role if economies of scale and innovation are linked. Studies analysing the implications of endogenous technological change have suggested that the R&D process of innovating new varieties is subject to economies of scale. This indicates a close link between market size effects and the nature of technological change and together points towards theories of technological change. To the extent that economies of scale are an important factor in shaping technological change, the channel identified in my analysis would be even more important for the evolution of skill premia over time.

Bibliography

- Acemoglu, D. (1998). Why do new technologies complement skills? directed technical change and wage inequality. *The Quarterly Journal of Economics* 113(4), 1055–1089.
- Acemoglu, D. (2002). Directed technical change. *The Review of Economic Studies* 69(4), 781–809.
- Acemoglu, D. (2003). Patterns of skill premia. *The Review of Economic Studies* 70(2), 199–230.
- Acemoglu, D. and F. Zilibotti (2001). Productivity differences. *The Quarterly Journal of Economics* 116(2), 563–606.
- Barro, R. J. and J. W. Lee (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of development economics* 104, 184–198.
- Broda, C., J. Greenfield, and D. Weinstein (2006). From groundnuts to globalization: A structural estimate of trade and growth. Technical report, National Bureau of Economic Research.
- Card, D. and J. E. DiNardo (2002). Skill-biased technological change and rising wage inequality: some problems and puzzles. *Journal of Labor Economics* 20(4), 733–783.

- Caselli, F. (2005). Accounting for cross-country income differences. *Handbook of economic growth* 1, 679–741.
- Caselli, F. and W. J. Coleman (2006). The world technology frontier. *The American Economic Review* 96(3), 499–522.
- Epifani, P. and G. Gancia (2006). Increasing returns, imperfect competition, and factor prices. *The Review of Economics and Statistics* 88(4), 583–598.
- Epifani, P. and G. Gancia (2008). The skill bias of world trade. *The Economic Journal* 118(530), 927–960.
- Feenstra, R. C. (1994). New product varieties and the measurement of international prices. *The American Economic Review*, 157–177.
- Feenstra, R. C. and J. Romalis (2014). International prices and endogenous quality. *The Quarterly Journal of Economics* 129(2), 477–527.
- Freeman, R. B. and R. H. Oostendorp (2005). Occupational wages around the world (oww) database.
- Gasparini, L., S. Galiani, G. Cruces, and P. Acosta (2011). Educational upgrading and returns to skills in latin america: evidence from a supply-demand framework, 1990-2010.
- Haskel, J. E. and M. J. Slaughter (2002). Does the sector bias of skill-biased technical change explain changing skill premia? *European Economic Review* 46(10), 1757–1783.
- Kahn, J. A. and J.-S. Lim (1998). Skilled labor-augmenting technical progress in us manufacturing. *Quarterly Journal of Economics* 113(4).

- Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review* 70(5), 950–959.
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of political economy* 99(3), 483–499.
- Morrison Paul, C. J. and D. S. Siegel (1999). Scale economies and industry agglomeration externalities: a dynamic cost function approach. *American Economic Review* 89(1), 272–290.
- Solow, R. M. (1957). Technical change and the aggregate production function. *The review of Economics and Statistics* 39(3), 312–320.

Appendix A

A.1 Background and Data Description

LIAB Data

Data Access

This study uses the Linked-Employer-Employee Data (LIAB) cross-sectional model 2 1993-2014 (LIAB QM2 9314), provided by the German Institute for Employment Research (IAB). Data access was provided via on-site use at the UK Data Archive at the University of Essex and subsequently remote data access.

Complexity of tasks performed

Occupations can be described on the basis of the requirement level. The objective of classifying occupations according to their complexity is to be able to depict the various degrees of complexity within those occupations which have a high similarity of occupational expertise. Four Requirement Levels are distinguished to map the degree of complexity of an occupation. The assumption behind it is that a certain standard of skills, abilities and knowledge must exist for practicing a certain occupation. The standard of skills, abilities and knowledge required for practicing an occupation need not be based on the educational level, but can also be acquired through work experience and learning-by-doing. Here, the formal qualification of the person practicing the occupation is irrelevant; the subject of consideration is rather the Requirement Level that is typically demanded for this occupational activity.¹⁴

¹⁴For further information see ?.

Foreign Direct Investment (FDI)

Definition

According to international standards, FDI refers to cross-border investments made by residents and businesses from one country into another, with the aim of establishing a lasting investment in the company receiving investment. The “lasting interest” is evidenced when the direct investor owns at least 10% of the voting power of the direct investment enterprise.¹⁵ Furthermore, one can distinguish between inward and outward FDI: The outward FDI stock is the value of the resident investors’ equity in and net loans to enterprises in foreign economies. The inward FDI stock is the value of foreign investors’ equity in and net loans to enterprises resident in the reporting economy.

German FDI

Germany is one of the main recipients and source countries of FDI in the world, where it is ranked 4th in terms of outward FDI and 6th with respect to inward FDI stocks in 2017 (see ?). Outward investment (46% of GDP in 2017) by German residents tends to be much larger than inward FDI (26% of GDP in 2017). Furthermore, FDI stock statistics, published by the Deutsche Bundesbank, show that more than half of Germany’s inward FDI originates from within the EU. In contrast, the main recipients of German outward FDI are invested in non-EU countries.¹⁶

¹⁵The ‘OECD Benchmark Definition of Foreign Direct Investment, 4th edition’, ?, provides operational guidelines on how foreign direct investment activity should be measured and sets the world standard for collecting direct investment statistics.

¹⁶It is important to additionally record secondary investment via dependent holding companies when analysing the main trends in cross-border investment. Consequently, FDI data usually refers to the consolidated sum of primary FDI and secondary FDI (held through dependent holding companies). The original investment in the holding company is factored out of the latter to avoid double counting.

A.2 Robustness Checks

This part of the Appendix contain the relevant tables for the robustness checks in section 3.3.

Table A.1: Robustness 1 - Unravelling the different Wage Premia (2006)

	(1)	(2)	(3)	(4)	(5)
	No Controls	+Size	+Industry	+Occ	+obs
<i>Exporter</i>	0.216*** (0.00125)	0.110*** (0.00124)	0.0412* (0.00148)	0.00305*** (0.00127)	0.0316*** (0.00116)
<i>MNE_{For}</i>	0.250*** (0.00231)	0.177*** (0.00222)	0.110*** (0.00219)	0.103*** (0.00187)	0.0846*** (0.00158)
<i>MNE_{Dom}</i>	0.172*** (0.00611)	0.105*** (0.00573)	0.107*** (0.00574)	0.0209*** (0.00489)	0.0372*** (0.00428)
<i>MNE_{Hyb}</i>	0.324*** (0.00346)	0.186*** (0.00333)	0.156*** (0.00326)	0.0645*** (0.00138)	0.0624*** (0.00116)
Observations	332,645	332,645	332,645	332,645	332,645
Firms	4,779	4,779	4,779	4,779	4,779
R^2	0.035	0.158	0.188	0.430	0.565

Notes: This Table presents estimation results equivalent to the ones in Table 3, where here workers are included that may only appear in the sample in 2006. The sample corresponds to full-time workers between 16 and 65 years of age, where data is available in 2006. Dependent variable is the log daily wage. Firm variables include the firm type (local, exporter and 3 different MNEs), the log of employment (size) and 17 industry catagories. Worker observables include: gender, age, nationality (dummy for foreign), tenure at the firm, 340 different occupations and the educational level. The education groups are defined as: 1) low: no vocational training, no high-school; 2) medium: high school and/or vocational training; 3) high: university or technical college. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.2: Robustness 2 - Controlling for Unobserved Heterogeneity

	(1)	(2)	(3)	(4)
<i>Exporter</i>	0.02258*** (0.00165)	0.0756*** (0.00576)		
<i>MNE</i>	0.102*** (0.00153)	0.0813*** (0.00549)		
<i>log size</i>	0.0776*** (0.000354)	0.0332*** (0.00142)	0.0463*** (0.00387)	0.0259*** (0.00221)
Individual FE		x		
Firm FE			x	
Spell FE				x
Time FE	x	x	x	x
Worker controls	x	x	x	x
Firm controls	x	x	x	x
Observations	425,323	425,323	425,323	425,323
Firms	4,774	4,774	4,774	4,774
R^2	0.541	0.545	0.434	0.547

Notes: The Table presents estimation results equivalent to the ones in Table 4, but I now exclude all firms that change their type between 2006 and 2010. The sample corresponds to full-time workers between 16 and 65 years of age, where data is available in both sample periods. Dependent variable is the log daily wage. Firm variables include the firm type (local, exporter and 3 different MNEs), the log of employment (size) and 17 industry categories. Worker observables include: gender, age, nationality (dummy for foreign), tenure at the firm, 340 different occupations and the educational level. The education groups are defined as: 1) low: no vocational training, no high-school; 2) medium: high school and/or vocational training; 3) high: university or technical college. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A.3: Robustness 3 - Firm Movers

	(1)	(2)	(3)	(4)
<i>Exporter</i>	0.0299*** (0.00112)	0.0206*** (0.000958)	0.0259*** (0.00165)	0.0191*** (0.000932)
<i>MNE</i>	0.0492*** (0.000932)	0.0269*** (0.00104)	0.0164*** (0.00181)	0.0250*** (0.00102)
<i>log size</i>	0.0691*** (0.000231)	0.0332*** (0.00109)	0.0488*** (0.00301)	0.0259*** (0.00171)
<i>Mover</i>	-0.0924*** (0.00246)		-0.0878*** (0.00319)	
Individual FE		x		
Firm FE			x	
Spell FE				x
Time FE	x	x	x	x
Worker controls	x	x	x	x
Firm controls	x	x	x	x
Observations	665290	665290	665290	665290
Firms	5,490	5,490	5,490	5,490
R^2	0.430	0.574	0.457	0.579

Notes: This Table presents estimation results equivalent to the ones in Table 4, additionally including a dummy variable for whether a worker transitions to a different firm between 2006 and 2010. Regressions based on LIAB data for the year 2006 and 2010. The sample corresponds to full-time workers between 16 and 65 years of age, where data is available in both sample periods. Dependent variable is the log daily wage. See notes of table 3 for the set of firm and worker observables. Standard errors in parentheses. Asterisks indicate significance at: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B

A.1 Wage Bargaining

I follow Stole and Zwiebel (1996) and assume that wages are determined by continuous bargaining between the firm and its employees. Before production takes place, firms and workers can engage in an arbitrary number of pairwise negotiations, where wage contracts are unenforceable: the firm may fire any employee and any employee may decide to quit. If the worker is forced to, or voluntarily enters into unemployment, where in the baseline model the value of being unemployed (\underline{w}) is normalised to zero. It is assumed that once negotiations begin the firm cannot hire additional employees from the unemployment pool. All the firm's other decisions – sampling, screening, production, exporting – are sunk by the bargaining stage and can thus, be regarded as state variables for the firm.

Stole and Zwiebel (1996) formally characterize the stable division of production into wages and profits such that renegotiating improves neither the firm's nor the workers' pay-offs. They show that the stable profile can be derived as the unique subgame perfect equilibrium of an extensive form game where the firm and workers play the alternating-offer bargaining game of Binmore, Rubinstein, and Wolinsky (1986) within each bargaining session. The stable profile is characterized by the following generalised Nash-bargaining condition between the firm and its h employees:

$$\lambda \frac{\partial}{\partial h} [r(Z, h) - w(Z, h)h] = (1 - \lambda)w(Z, h)$$

where λ represents the bargaining power of the firm. This equation implies that the surplus of a worker from employment ($w(Z, h)$) is equal to the marginal surplus of the

firm from employing the worker, weighted by their respective bargaining powers.¹⁷ Using the assumed functional forms for revenues this differential equation yields the solution

$$w(\theta) = \frac{\lambda\beta\gamma}{1 - \lambda + \lambda\beta\gamma} \frac{r(Z)}{h(Z)}$$

And with equal bargaining power between the firm and workers and assuming that $\underline{w} = 0$:

$$w(Z) = \frac{\beta\gamma}{1 + \beta\gamma} \frac{r(Z)}{h(Z)} \quad (22)$$

Thus, as in ? the wage is equal to the the worker's share of his contribution to the value of the firm, taking into account that if the worker were to quit, this would also influence the wages of other employees of the firm.

¹⁷Stole and Zwiebel (1996) show that because if a worker quits, renegotiations ensue with all remaining workers, and this in turn allows a worker to obtain the same share of surplus associated with workers prior to him in the order as those after him. Thus, this structure allows workers, through their ability to renegotiate if breakdown occurs later, to effectively achieve the same outcome as a wage agreement up front that is contingent on which workers are ultimately present.

A.2 Firm's optimisation problem

Given the profit function as in (10), a firm's first order condition for the number of workers sampled for the home establishment (n_H) and additionally if a firm is a MNE for the foreign establishment (n_F) are: the firm's first order conditions for the measure of workers sampled for the home establishment (n_H), the foreign affiliate (n_F) and the screening ability threshold (a_c) are:

$$\frac{\beta\gamma}{1+\beta\gamma}\Upsilon_H^{1-\beta}A\left(\frac{k}{k-1}zn_H^\gamma a_{c,H}^{1-\gamma k}\right)^\beta \equiv \frac{\beta\gamma}{1+\beta\gamma}r_H = bn_H \quad (23)$$

$$\frac{\beta\gamma}{1+\beta\gamma}A^*\left(\frac{k}{k-1}zn_F^\gamma a_c^{1-\gamma k}\right)^\beta \equiv \frac{\beta\gamma}{1+\beta\gamma}r_F = bn_F \quad (24)$$

$$\frac{\beta(1-\gamma k)}{1+\beta\gamma}\left[\Upsilon_H^{1-\beta}A\left(\frac{k}{k-1}zn_H^\gamma a_{c,H}^{1-\gamma k}\right)^\beta + I_i A^*\left(\frac{k}{k-1}zn_F^\gamma a_{c,i}^{1-\gamma k}\right)^\beta\right] = \frac{c}{d}a_c^\delta \quad (25)$$

Combining equations (37) and (38), number of workers sampled in home plant relative to foreign plant for a given firm is given by

$$\frac{n_H}{n_F^*} = \left(\frac{b}{b^*}\frac{A^*}{A}\right)^{-\frac{1}{1-\gamma\beta}} \quad (26)$$

A.3 Unemployment

In the model workers can be unemployed either because they are not matched with a firm or because their match-specific ability draw is below the screening threshold (a_c) of the firm with which they are matched. Both components of unemployment are frictional in the sense that workers cannot immediately achieve another match. The sectoral unemployment rate u includes both of these components and can be written as follows:

$$u = \frac{l - h}{l} = 1 - \frac{h}{n} \frac{n}{l} = 1 - \sigma x \quad (27)$$

where, H is the measure of hired workers, n is the measure of matched workers, and L is the measure of workers seeking employment in the sector. Then $\sigma = h/n$ captures the fraction of interviewed workers that are actually hired and $x = n/l$ denotes the number of interviews per job seeker.

In a next step, it is straight forward to derive the aggregate unemployment rate U in the economy. It can be expressed as a weighted average of the rates of unemployment in the homogeneous and differentiated sectors. With no unemployment in the homogeneous sector, the aggregate rate of unemployment is therefore equal to the unemployment rate in the differentiated sector times the share of the labor force in this sector:

$$U = \frac{l}{L} u \quad (28)$$

Appendix C

C.1 Theory

Derivation of output equation (10)

From equation (4) and (7) it follows that $P_{it}Q_{it} = B_{it}$; together with equation (2) we get

$$P_{it}Q_{it} = \left[\frac{1}{Z_{it}} \left(\frac{w_{Lt}}{1 - \alpha_i} \right)^{1 - \alpha_i} \left(\frac{w_{Ht}}{\alpha_i} \right)^{\alpha_i} \right]^{1 - \beta} \times \left[\int_0^{M_{it}} p_{it}(m)^{1 - \varepsilon} dm \right]^{\frac{\beta}{(1 - \varepsilon)}} Q_{it}$$

Next, we solve (9) with (6), which yields

$$p_{it}(m) = \left(\frac{\varepsilon}{\varepsilon - 1} \right) \frac{1}{Z_{it}} \left(\frac{w_{Lt}}{1 - \alpha_i} \right)^{1 - \alpha_i} \left(\frac{w_{Ht}}{\alpha_i} \right)^{\alpha_i}$$

Furthermore, plugging this expression into the previous one and using the expression for factor shares $w_{Ht}H_{it}/P_{it}Q_{it} = \alpha_i$ and $w_{Lt}L_{it}/P_{it}Q_{it} = 1 - \alpha_i$ we get

$$P_{it}Q_{it} = M_{it}^{\frac{\beta}{1 - \varepsilon}} Q_{it} \frac{1}{Z_{it}} \left(\frac{\varepsilon}{\varepsilon - 1} \right)^{\beta} (P_{it}Q_{it})^{1 - \alpha_i} L_{it}^{\alpha_i - 1} H_{it}^{-\alpha_i}$$

Lastly, we arrange this equation for Q_{it} , which yields equation (10):

$$Q_{it} = M_{it}^{\mu} \left(\frac{\varepsilon}{\varepsilon - 1} \right)^{-\beta} \frac{\varepsilon}{\beta}$$

Expression for the Skill-Premium

Given equation (11), we next find the demand for low and high-skilled workers (see equation (8) and (9)), which I derive using Shephard's lemma,

$$L_t = \frac{\varepsilon}{\beta} \frac{1}{Z_{Lt}} \left(\frac{1 - \alpha_L}{\alpha_L} \frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_L} M_{Lt} + \frac{\varepsilon}{\beta} \frac{1}{Z_{Ht}} \left(\frac{1 - \alpha_H}{\alpha_H} \frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_H} M_{Ht}$$

$$H_t = \frac{\varepsilon}{\beta} \frac{1}{Z_{Lt}} \left(\frac{1 - \alpha_L}{\alpha_L} \frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_L - 1} M_{Lt} + \frac{\varepsilon}{\beta} \frac{1}{Z_{Ht}} \left(\frac{1 - \alpha_H}{\alpha_H} \frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_H - 1} M_{Ht}$$

We can now use the expression for L_t and H_t to solve for the measures of input varieties M_{Ht} and M_{Lt}

$$\begin{aligned} M_{Lt} &= \frac{\left[\alpha_H L_t - (1 - \alpha_H) H_t \left(\frac{w_{Ht}}{w_{Lt}} \right) \right] \beta Z_{Lt} (1 - \alpha_L)^{(1 - \alpha_L)} \alpha_L^{\alpha_L}}{\varepsilon (\alpha_L - \alpha_H) \left(\frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_L}} \\ &= \frac{\left[\alpha_H - (1 - \alpha_H) \frac{H_t}{L_t} \left(\frac{w_{Ht}}{w_{Lt}} \right) \right] \beta Z_{Lt} (1 - \alpha_L)^{(1 - \alpha_L)} \alpha_L^{\alpha_L}}{\varepsilon (\alpha_L - \alpha_H) \left(\frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_L}} \end{aligned}$$

$$\begin{aligned} M_{Ht} &= \frac{\left[(1 - \alpha_L) H_t \left(\frac{w_{Ht}}{w_{Lt}} \right) - \alpha_L L_t \right] \beta Z_{Ht} (1 - \alpha_H)^{(1 - \alpha_H)} \alpha_H^{\alpha_H}}{\varepsilon (\alpha_H - \alpha_L) \left(\frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_H}} \\ &= \frac{\left[(1 - \alpha_L) \frac{H_t}{L_t} \left(\frac{w_{Ht}}{w_{Lt}} \right) - \alpha_L \right] \beta Z_{Ht} (1 - \alpha_H)^{(1 - \alpha_H)} \alpha_H^{\alpha_H}}{\varepsilon (\alpha_H - \alpha_L) \left(\frac{w_{Ht}}{w_{Lt}} \right)^{\alpha_H}} \end{aligned}$$

Finally, plugging the expression for M_{Ht} and M_{Lt} back into equation (11), yields the expression of the skill premium in equation (12).

C.2 Data

Table C.1: Countries in the Sample

Country	Code	High-Income
Argentina	AR	no
Austria	AT	yes
Australia	AU	yes
Belgium	BE	yes
Bulgaria	BG	no
Bolivia	BO	no
Brazil	BR	no
Canada	CA	yes
Cote d'Ivoire	CI	no
China	CN	no
Costa Rica	CR	no
Germany	DE	yes
Denmark	DK	yes
Egypt	EG	no
Finland	FI	yes
United Kingdom	GB	yes
Guyana	GY	no
Hong Kong	HK	yes
Indonesia	ID	no
India	IN	no
Italy	IT	yes
Japan	JP	yes
Republic of Korea	KR	no
Sri Lanka	LK	no
Mayanmar	MM	no
Mauritius	MU	no
Mexico	MX	no
Peru	PE	no
Philippines	PH	no
Russia	RU	no
El Salvador	SV	no
Thailand	TH	no
Turkey	TR	no
Trinidad & Tobago	TT	no
United States	US	yes
Venezuela	VE	no